RADIO

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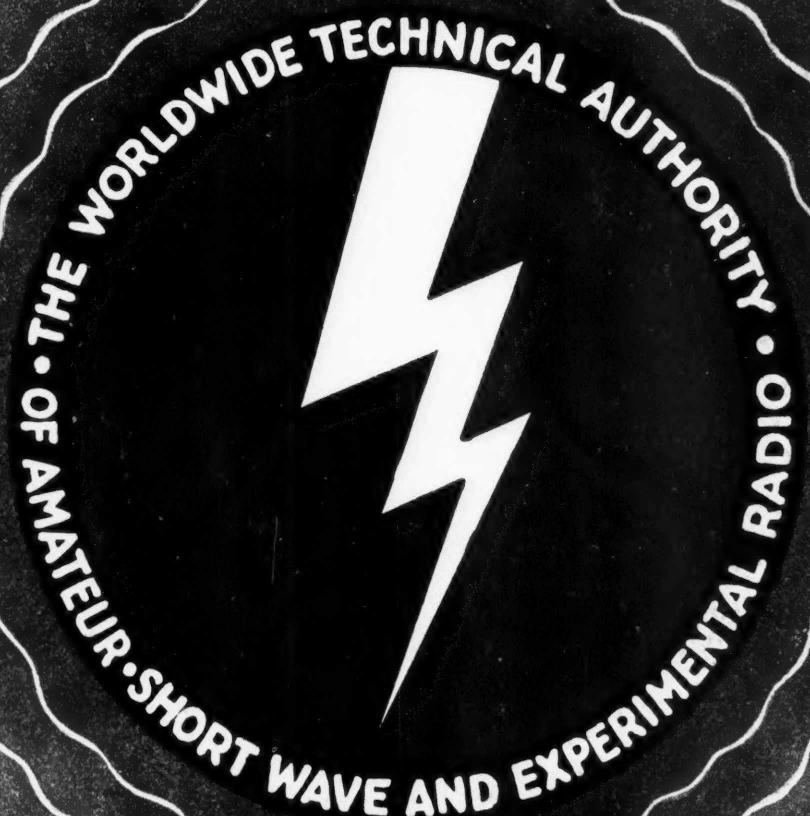

This Month

A Revolutionary New 45 Watt Exciter Unit

◆

Improved Suppression of Harmonic Radiation

◆

Simplified 10 Meter Mobile Crystal Control

◆

A Home-Made Bandswitching Superheterodyne

◆

Stabilized Feedback in Radio Transmitters

THE WORLDWIDE TECHNICAL AUTHORITY OF AMATEUR, SHORT WAVE, AND EXPERIMENTAL RADIO

RADIO

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No. 218 April, 1937

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"RADIO" CONTRIBUTIONS

Contributions to our editorial pages are always welcome; though they will be handled with due care we assume no responsibility for those which are unsolicited; none will be returned unless accompanied by a stamped, addressed envelope. We do not suggest subjects on which to write; cover those you know best; upon request, we will comment on detailed outlines of proposed articles, but without committing ourselves to accept the finished manuscript.

Since we regard current "chiseling" policies as decidedly unfair, a small payment will be made, usually upon publication, for accepted material of a technical or constructional nature. Freehand, pencilled sketches will suffice. Good photographs add greatly to any article; they can easily be taken by the layman under proper instructions. For further details regarding the taking of photographs and the submission of contributions see "Radio" for January, 1936, or send stamp for a reprint.

The "Bi-Push" Tri-Band Exciter or Transmitter

By W. W. Smith, W6BCX

IT'S HERE

Just what you have been waiting for in a low-powered transmitter or high-power high-frequency exciter

40 to 45 watts output on 10, 20, and 40 meters

•

One crystal and only 3 single-winding coils cover all three bands

•

Less than 20 seconds to change bands

•

May be used either as an exciter or c.w. rig

•

May be high-level modulated for 10 or 20 meter phone

•

No neutralization, no shielding, no coupling adjustments

•

Only three variable tuning condensers, no more

•

Four inexpensive, receiving-type tubes

The simplest, most economical, most inexpensive, most efficient 10-20-40 meter rig you have ever seen

Just how much of a transmitter constitutes the "exciter"? Pondering upon this, a review of the various multi-band "exciters" brought out during the last few years revealed just one thing: The multi-band exciter problem has been approached from the wrong angle. The exciter should be considered as integral with the transmitter, and not as a separate item divorced from the "transmitter" (meaning the last stage or two in the transmitter).

We have seen some very wonderful one-tube exciters that delivered output on 4 or 5 bands—with as much as 25 or 30 watts on the fundamental frequency. But the output on the highest frequency, being but from 1 to 3 watts, dictates that the following stage be designed to get along with but from 1 to 3 watts excitation. What good in this case is the 25 watt fundamental output?

The unit shown in the photographs delivers approximately 40 watts on 40 meters and 40-45 watts on 20 and 10 meters. Only three coils (*not* three *sets* of coils) are needed to hit these three bands with a 40 meter crystal. And it may be high-level modulated for 10 and 20 meter phone. If one wants more power in the antenna than 40-45 watts, he can add a high power stage with the assurance that there will be sufficient excitation on *all* bands, and not an excess on one band and a deficiency on another. The unit will satisfactorily drive a plate-modulated amplifier at 300 watts input, or a c.w. amplifier at from 500 to 1000 watts input, depending upon the plate efficiency required or desired.

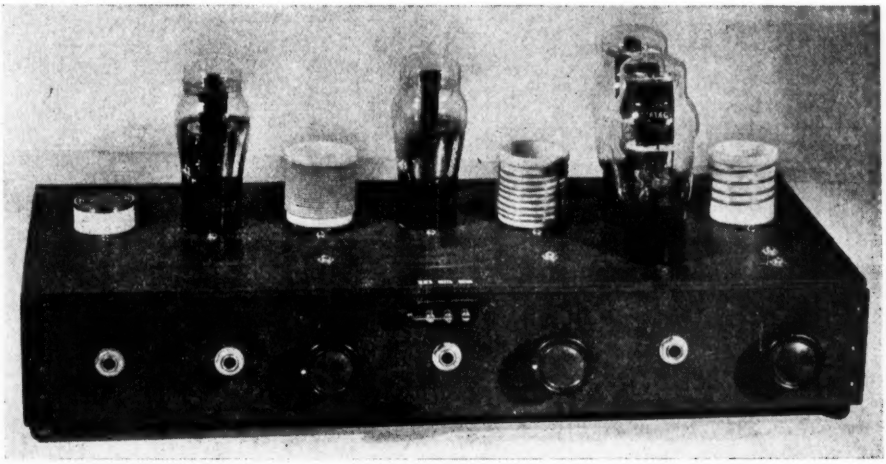
What we have done is to simplify greatly the low power transmitter, and then consider the whole thing as an integral unit rather than part of it as an "exciter". The whole low power transmitter can be considered as an "exciter" when driving a high power amplifier. This, we believe, is the proper light in which to consider the question of "When is an exciter not an exciter", or "How is an exciter and if so why not?"

The New "Exciter" Conception

Inspection of the wiring diagram discloses some rather tricky coils. However, there are but three of them, and they are very easy to wind. With the crystal in the left hand socket (the crystal holder must be of the type that fits a five-prong tube socket), coil 1 in socket "A", coil 2 in socket "B", and coil 3 in socket "C", we have a 40 meter push-pull crystal oscillator, driving a 20 meter push-push doubler, driving a 10 meter push-push doubler to over 40 watts output.

To go on 20 meters we insert the crystal in socket "A", coil 1 in socket "B", and coil 2 in socket "C". Now we have a 40 meter push-pull crystal oscillator driving a 20 meter push-push doubler. The output is the same as on 10 meters.

To go on 40 meters we insert the crystal in socket "B" and coil 1 in socket "C". We now



Front of the "Bi-Push" Exciter. A "DeLuxe" Rack-Mounting Version Will Be Shown in an Early Issue.

have a push-pull 6L6-G crystal oscillator that delivers approximately 40 watts and keys very nicely (provided a good crystal is used).

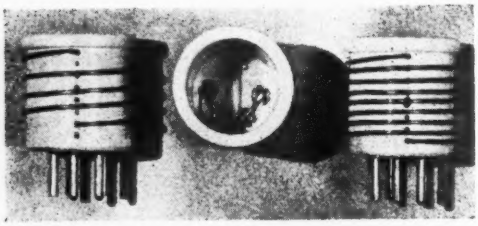
On 20 meters the plate voltage is automatically removed from the first 6A6, and on 40 meters it is automatically removed from both the first and second 6A6's. Thus a minimum of equipment and input power is used on each band.

Because the tubes require high gridleak bias for efficient operation as push-push doublers, and because the gridleak bias causes rather high crystal current when the tube is used as a push-pull oscillator, the bandswitch shown is incorporated in order to short out the gridleak on whatever stage is being used as the crystal oscillator. As the first tube is used only as an oscillator and therefore requires no gridleak, the open position of the switch corresponds to 10 meters (the only band on which the first tube is used).

This switch may be an inexpensive midget knife-switch, or a well-insulated s.p.d.t. toggle switch with a neutral position. However, it is very important that the switch be thrown to the proper position when changing bands. With an A-T cut crystal the only thing that occurs with failure to throw the switch is slightly reduced output. But with all other type 40 meter crystals the crystal current is likely to fracture the crystal. With the switch in the proper position the crystal current runs around 70 ma. on 10 and 20 meters, and approximately 85 ma. on 40 meters. The crystal current does not rise to a dangerous value on 40 meters when the load is removed from the tank, due to the fact that a series screen dropping resistor and cathode bias are used. When the load is removed, the screen current increases, which drops the screen voltage, which in turn tends to lower the crystal current. Also, due to the reduced plate current, the cathode bias decreases when the load is removed which tends to offset the increase in crystal current that results from the greater r.f. potential developed across the tank coil when the load is removed.

The numerals "7", "14", and "28" can be cut from a small calendar and pasted on the panel above the switch to indicate the proper position for each band. If you are inclined to be forgetful, you had best use some numerals an inch or so high as a gentle reminder, because if you neglect to throw the switch and an A-T cut crystal is not used, the chances are your crystal will fracture. However, if one does not get in too big a hurry when changing bands, there is no excuse for not remembering to throw the switch.

If you should be worried for fear that you may some time forget this little chore, and you want to use an X-cut crystal, the switch can be dispensed with by resorting to 7-prong coil forms and putting a jumper across the two unused pins in the *40 meter coil only,* leaving the extra pins "floating" in the 20 and 10 meter coils. One of the extra prongs on coil socket "B" would go to ground and the other to the top of R_3. One of the extra prongs on coil socket "C" would go to ground and the other



These 3 Coils Cover All 3 Bands. Left to Right: 10, 40, and 20 Meter Coils.

to the ungrounded end of R_6. The switch is then not required, as the shorting of the proper gridleak is accomplished automatically with the changing of coils.

Winding the Coils

The three coils illustrated are wound on XR-20-5 isolantite coil forms. These are very inexpensive and are also desirable from several other standpoints. Their small size allows a minimum of supporting material in the field of the coil. Their ratio of length to width permits a good form factor, at the same time providing sufficient winding space for the frequencies involved. Also, they are much easier to "get into" with a soldering iron (necessary to make the "jumpered" connections inside the coil form). In fact, if regulation height coil forms are used, it is almost impossible to make these connections inside the form. If such taller forms are used, the best way to make the connections outside the forms is to use long solder lugs that will slip over one prong and reach the pin to which jumpering is necessary. Copper lugs are preferable to brass lugs for this use, as considerable r.f. current has to be carried by the jumpers.

With this type of jumpering, the coils cannot be pushed all the way down into the sockets, but can be pushed down far enough to make good contact, an impossibility if wire external jumpers are used instead of flat lugs.

The method of external jumpering (not necessary with the short XR-20 forms) is described because some will want to use 7-prong forms in order to dispense with the band-change switch as previously described. Unfortunately, the XR-20 forms are not available with 7 prongs.

To wind the coils shown with the transmitter, 10 or 15 feet of number 18 d.c.c. and 8 or 10 feet of either bare copper or d.c.c. no. 16 wire are required. Also procure a small amount of Victron coil dope.

The 10 and 20 meter coils are space wound with no. 16 bare copper. If this is not available, no. 16 d.c.c. may be skinned with a pair of diagonals. The skinned d.c.c. is easier to solder to, as the cotton covering keeps the surface of the wire from tarnishing with age, and when the insulation is removed the wire is very shiny and takes solder without any trouble.

Before starting to wind the coils, the forms should be baked for a half hour (or suspended over a stove or heater) in order to drive out any moisture that they might have absorbed. The forms are left unglazed in order to take coil dope better, and even the best of ceramics will absorb moisture over a period of time unless glazed or impregnated with wax or coil dope.

To make the winding process easier, we will arbitrarily number the coil form pins in a clockwise direction, starting with the "grid" pin (isolated pin) as number 1, *looking down into the forms from the top.* The socket connections shown in the wiring diagram are for the *bottom* views of the sockets, and will cause confusion when applied to the coil forms themselves, as we are working on the forms from the *top.*

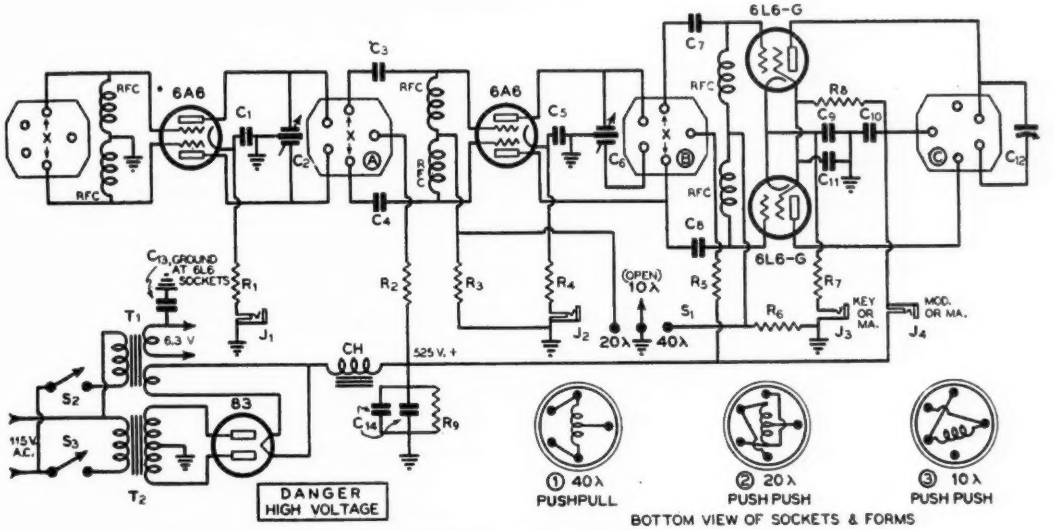
There are 8 small holes spaced along each form (near pin 4) that the manufacturer had moulded into the forms for the main and simple reason that the coil form material is undrillable with common tools. We will designate these holes as nos. 1 to 8, starting at the bottom of the form (no. 1 hole closest to the end of the form on which the pins are located).

The 10 Meter Coil

With one end of about 3 feet of the no. 16 in a vise or fastened to some solid object, stretch it until all kinks are removed. Then insert the wire through hole 2 and solder it to pin 3. Because the pins are brass and not as good conductors as copper, it is a good idea to solder the wire at the *tip* of the pin as is the usual practice and also *inside* the coil form where the jumpers are placed. However, soldering the tips is not absolutely necessary if good soldered joints inside the coil form are made.

COIL POSITIONS FOR DIFFERENT BANDS

Freq.	*Xtal.*	*Coil 1*	*Coil 2*	*Coil 3*
7 Mc.	"B"	"C"		
14 Mc.	"A"	"B"	"C"	
28 Mc.	"X"	"A"	"B"	"C"



The General Wiring Diagram

C_1—.004 μfd. mica
C_2—100-100 μμfd. midget split stator
C_3, C_4—150 μμfd. mica
C_5—.004 μfd. mica
C_6—100-100 μμfd. midget split stator
C_7, C_8—500 μμfd. mica
C_9, C_{10}, C_{11}—.004 μfd. mica
C_{12}—50 μμfd. midget, 1000 volt spacing, isolantite insulation
C_{13}—.004 μfd. mica
C_{14}—Either one or two 4 μfd., 600 working volt oil condensers (see text)

NOTE: All mica condensers are 1000 volt test. C_{10} should be 2500 volt test if telephony is to be used.

R_1—400 ohms, 10 watts
R_2—4000 ohms, 30 watts or more, wire-wound
R_3—10,000 ohms, 10 watts
R_4—400 ohms, 10 watts
R_5—4000 ohms, 30 watts or more, wire-wound
R_6—Two 100,000 ohm, 2 watt carbon resistors in parallel (50,000 ohms)
R_7—200 ohms, 10 watts
R_8—15,000 ohms, 10 watts
R_9—40,000 ohms, 20 watts
T_1—6.3 v. at 4 amp. and 5 v. at 3 amp.
T_2—700 v. each side c.t., 150 watts
CH—5-25 hy., 300 ma. swinging choke

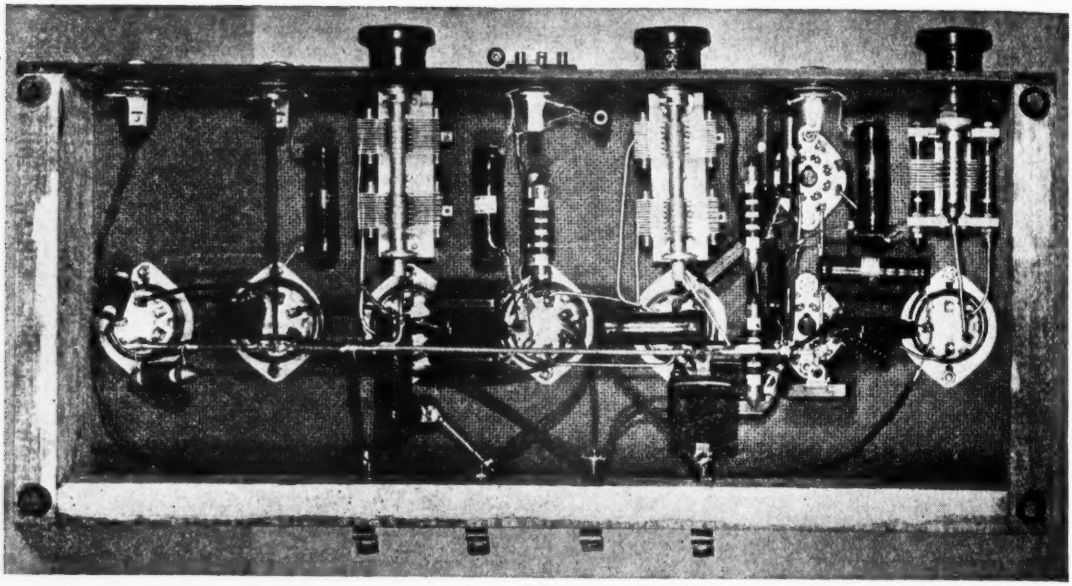
With one end of the wire still in the vise to keep the wire taut, wind 4 equally-spaced turns and bring the wire through hole 8. It will be impossible to get the no. 16 wire to fit the form tightly regardless of how hard one pulls it through hole 8. However, this is not important, as the wire is carefully spaced later and coil dope applied to hold the turns in place. Pull the wire through pin 4 and solder. Now, with short lengths of the same wire, jumper pin number 1 to pin 3, and pin 2 to pin 4. The coil is then completed except for the coil dope, which is later applied to all three coils at the same time.

The 20 Meter Coil

The balance of the bare no. 16 is placed in the vise and the stretching operation repeated. Insert the free end through hole 1 and solder it to pin 4. Wind 8 equally-spaced turns and bring the wire through hole 8, soldering to pin 3. Next jumper pin 2 to pin 4, and pin 3 to pin 5 with as short leads as is possible without the jumpers shorting with each other. Next take 2 inches of the no. 18 d.c.c. and remove the cotton covering. With long-nosed pliers, make a very sharp U-bend in one end, so that the U will fit snugly half way around a piece of no. 16 wire. Slip the straight end through hole 4, with the U upward, and hook the U over the 4th turn of the coil (center turn) and solder. Draw the other end of the wire through pin 1 and solder. The coil is then completed except for coil dope.

The 40 Meter Coil

The 40 meter coil is wound with no. 18 d.c.c. With one end in a vise, stretch the wire to remove kinks and run the free end through hole 1, soldering to pin 3. Wind 18 turns and draw through hole 8, soldering to pin 5. The spacing can be taken care of later. Jumper pin 2 to pin 3, and pin 4 to pin 5. With knife or razor blade remove about a quarter inch of the cotton covering of the center turn (9 turns from either end) directly in line with the holes in the form. Hook a piece of wire the same as for the 20 meter coil, and run the straight end through hole 5, slipping the hook over the scraped center turn and soldering in place. Be careful that the U does not short through the insulation on the adjacent turns. The adjacent turns can be given a little extra spacing if neces-



Under-Chassis View of the Exciter. Note the Small Parasitic Choke Between the Lower 6L6 Socket and the Final Coil Socket.

sary. Solder this wire to pin 1 and the coil is completed.

Doping the Coils

Next the turns of all three coils are spaced by eye as accurately as possible and Victron coil dope ("Q-Max" coil dope, National Victron coil dope, etc.) applied to hold the turns in place. A small five-cent brush is satisfactory for the application of the dope. After the dope is thoroughly dry (several hours) a second coat should be applied. This will hold the turns firmly in place. Do not try to speed up the drying process by heating or holding the forms over a fire. The dope must dry slowly in order to dry properly.

Doping the coils, besides holding the turns in place and keeping out moisture, adds to the appearance. It keeps the bare copper wire from tarnishing, and colors the white d.c.c. covering on the 40 meter coil just enough that it matches the bare copper coils. Do *not* try to enhance the appearance of the 10 and 20 meter coils by winding them with tinned wire instead of bare copper. The coating of tin increases the r.f. resistance of the wire considerably, especially at 10 and 20 meters.

"DeLuxe" Coils

A well-known transmitting coil manufacturer has brought out a set of matched coils for the "bi-push", with all jumpers and connections properly made to match the diagram shown herewith. Besides having a minimum of supporting material in the field of the coil, and no wires running through the inside of the coil, the coils are mounted in a horizontal position instead of vertically, making them preferable for use with a metal chassis layout.

Construction

The chassis is made up of ¾" soft pine and tempered masonite, wiped off with oil stain to add to the appearance. The sides and back of the chassis are of pine, the top and front of masonite. Although the unit could have been made more compact, it was made 17 inches wide in order that it could be put in a standard rack if desired. The top piece of masonite measures 8" x 17" and the front piece 2¾" x 17".

Because of the several resistors used (three or four run quite hot) it is necessary to provide sufficient ventilation under the chassis to keep the other components and chassis cool. Four rubber feet are tacked to the bottom of the chassis to raise it up a little, allowing air to enter from underneath. At each end of the pine back of the chassis a ½" hole is drilled near the top. These holes, in addition to the "ports" provided by the jacks on the front panel, allow sufficient circulation of air.

There is no reason why the unit cannot be built on a metal chassis instead of the type shown. It is necessary to insulate C_{12} and J_4

from the panel if a metal chassis is used, but all other jacks and condensers may be mounted directly on the metal chassis. There will be a very slight reduction in output with a metal chassis due to the fact that there is more metal in the field of the coils, due to the vertical mounting. However, the difference in output is small.

Looking at the front of the unit for a moment, the corresponding tank condenser is mounted directly in front of each coil, and each cathode jack is mounted directly in front of the corresponding tube (or tubes).

The jack to the extreme left of the panel is J_4, the modulation or meter jack for the final stage. Except for this jack, the physical layout follows the wiring diagram layout very closely. This procedure usually allows very short r.f. leads.

Wiring

A good procedure to follow in wiring the unit, or any unit for that matter, is to copy the diagram in pencil on a large sheet of paper, transcribing the component values directly onto the pencil diagram from the caption in the article. This will familiarize one with the circuit and the values. Then, as each wire is soldered, the corresponding wire in the pencil diagram can be overdrawn with a red pencil or crayon. Unless one has done a lot of wiring and is very adept at it, the using of an auxiliary diagram and a colored pencil will actually speed up the wiring job, besides reducing the chance for error.

Ordinary tinned hookup wire should not be used for wiring the r.f. tank circuits. Tinned push-back wire is used for the d.c. circuits, and may be used for the r.f. leads in the 6A6 stages, but the leads to the tank condensers, to all three variable condensers, and *all* r.f. leads in the 6L6 stage should be made with no. 16 bare copper wire. No. 16 d.c.c. can be shorn of its insulation and used for these circuits, as it will be nice and shiny and will take solder easily.

A piece of no. 8 copper wire or 1/8" copper tubing about 12 inches long should be scraped clean with steel wool or a razor blade and used as a ground bus, all ground returns being made directly to this bus. The position of this wire, which starts at the crystal holder and runs lengthwise of the chassis, may be seen in the under-chassis view.

The resistors R_2 and R_5 act both as dropping resistors and r.f. chokes. For the latter reason, the resistors should be mounted close to the coil sockets. These resistors run quite hot, and should not be mounted closer than 1/2 inch to the masonite panel. They have very little r.f. to handle, but are necessary to keep the push-push circuits from self-oscillating.

Because a common heater supply is used, cathode keying of the 6L6 stage makes it advisable to leave the heater circuit "floating" (ungrounded). C_{13} should be placed directly at one 6L6 socket so that the heater circuit will be grounded to r.f. Incidentally, heavy enough heater wires should be used between the exciter unit and the power supply that there is a full 6.3 volts at the heater terminals; otherwise the tubes will not perform at full efficiency.

Avoiding Parasitics

The exciter unit, when constructed according to directions, cannot be made to self-oscillate at any frequency near the crystal frequency. However, due to the extremely high transconductance of the 6L6 type tube, these tubes have a tendency toward an u.h.f. parasitic when used in pairs, regardless of whether they are in push-pull, push-push, or parallel. Such parasitics reduce the efficiency of the stage and sometimes result in erratic operation (due to the extra grid current resulting from the parasitic causing an increase in bias developed across the gridleak).

To avoid such parasitics, a small parasitic choke is placed in one 6L6 plate lead. It consists merely of 6 turns of the no. 16 wire used for wiring the circuit. Wrap 6 turns of this wire around a pencil, remove the pencil, space the turns the diameter of the wire, and use this for the connecting wire between the *bottom 6L6* and the coil socket (refer to diagram). Fewer turns are required if the parasitic choke is placed in this lead than if it is placed in the plate lead to the top 6L6. The choke should be placed *directly at the plate pin* of the lower 6L6 socket, and not an inch or two away.

This choke is very necessary to proper operation of the circuit. As it is nothing more than a few turns taken in the hookup wire, it is not shown as an r.f. choke in the diagram.

Shielding

Because no two stages are working on the same frequency, no shielding whatsoever is required. None of the stages can be made to self-oscillate on any band, regardless of condenser settings. It is impossible to get any output except crystal controlled output.

Debunking Push-Push

The efficiency of the 6L6's when working as push-push doublers is as high as when the tubes are used in parallel, neutralized and working on the same frequency as the preceding stage. The reason for this is that the push-push doubler, when properly operated, is actually a class C amplifier. The only requirement is that the bias be high enough that the excitation pulses are kept down to less than 90 degrees. For this reason, the linearity of the final amplifier of the unit shown is as good when plate-screen modulated as when 6L6's are worked "straight through". The tubes cannot be modulated on 40 meters, as they are then working as oscillators. But no one is going to be using the unit for 40 meter phone—at least in the U.S.A., anyway.

One advantage of the push-push doubler (besides giving good efficiency when doubling) is that it is nigh impossible to get noticeable output on any but the second harmonic of the input circuit. One does not have to worry about accidentally picking off the fundamental or third harmonic instead of the second, or of fundamental output appearing in the output tank along with the second harmonic.

Because of the very high gridleak bias used in the 6L6 stage when the tubes are doubling to 20 or 10 meters, most of the bias comes from the gridleak and but a small percentage from the cathode resistor. For this reason it is not necessary to bypass the cathode resistor with a high-capacity electrolytic condenser for phone, as degeneration in the cathode circuit is unimportant with such a high gridleak bias.

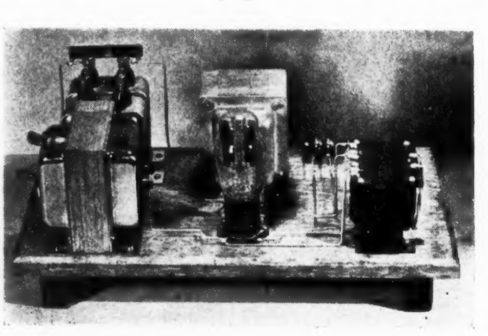
The Power Supply

The power supply should deliver between 525 and 550 volts under full load, and have excellent regulation. This means a mercury vapor rectifier and choke-input filter, with a low-d.c. resistance filter choke (not over 100 ohms). Good regulation is necessary because there is considerably less current drain on the power supply on 40 meters (without the first two stages working) and if the power supply does not have good regulation the plate voltage will rise to an excessive value.

For c.w. work, a single 4 μfd., 600 working volt condenser is sufficient, but if phone is to be used, two 4 μfd. sections in parallel should be used. The extra condenser will provide sufficient additional filtering for telephony, the hum level being very low if a husky input choke is used.

600-working-volt condensers will suffice *only* if a *swinging* filter choke and a bleeder of the value shown are used. Otherwise, the voltage will rise to considerably more than 600 volts when the key is up on 40 meters (at which time there would be no drain on the power supply except the bleeder resistor).

Although the 700 r.m.s. volts of the transformer is considerably greater than the maximum voltage rating for the 83, no concern need be felt for the tube if it is allowed to heat for 20 or 30 seconds before the plate voltage is applied. *Either* the voltage rating *or* the current rating of the type 83 may be exceeded somewhat without greatly shortening the life of the tube, so long as *both* are not exceeded. With a swinging input choke, the peak current rating of the 83 is not exceeded at the maximum current drawn by the exciter unit.



This One 550 Volt Power Supply Runs the Whole Exciter

Keying

Keying is accomplished by breaking the cathode lead of the 6L6 stage. The key is always inserted in J_3, regardless of whether operation is on 10, 20, or 40 meter c.w. The cathode bias holds the space current of the 6L6's down enough when excitation is killed that these tubes are not damaged *if not left on for more than a few seconds,* as would occur in tuning up. However, if the first or second 6A6 were keyed, there would be times when the key was up for long periods, and during such time the 6L6's would become too hot for their own good.

On c.w. the key is placed in J_3 and the meter in J_4, the latter measuring combined plate and screen current. For phone, the meter is inserted in J_3 and the modulator output in J_4. The jack J_3 adds the grid current to the plate-screen current, but as the grid current is so small (a couple of ma.) it may be ignored, and the meter reading taken as the plate-screen current.

When both plate and screen current are measured at the same time, the resonance dip with the tank unloaded will not be so pronounced as when the meter reads plate current alone. The reason for this is that with the tank unloaded the screen current increases.

By using a screen dropping resistor instead of a potentiometer arrangement, it is possible to get by with a single winding on the modulation transformer, and a special output transformer is not needed. The only requirement is that the transformer have a 3000 or 3500 ohm secondary tap.

A series dropping resistor is preferable to a potentiometer arrangement also for the reason that the screen dissipation is automatically limited. Contrary to popular opinion, the keying of the stage as a 40 meter crystal oscillator is not improved by using a voltage divider for screen voltage. With a voltage divider it is necessary to run considerably less screen voltage (reducing the output) so that when the load is removed from the final tank and the screen current increases, the screen dissipation is not exceeded.

"DeLuxe" 6L6G's

A slight increase in the efficiency and output on 10 meters can be obtained by substituting the Isolantite base 6L6G's recently brought out by one of the prominent tube manufacturers. These tubes cost about half again as much as the standard type 6L6G and are identical except for having a 6-prong Isolantite base instead of the octal-type black base. If the Isolantite base tubes are used, 6-prong sockets should be used instead of the octal type. One brand of black-base 6L6G blistered around the plate pin on 10 meters, but all other makes tried gave no trouble from this standpoint.

Tuning Up

The tuning up procedure is very simple and foolproof. On 40 meters, merely tune for greatest output, using as tight coupling as is consistent with clean keying. If the oscillator will not key cleanly when delivering 40 watts output, it usually means that the crystal is not a very active oscillator. Be sure before applying plate voltage that the bandswitch is in the proper position. Unless you are using an A-T cut crystal, failure to throw the switch may result in a fractured crystal. Do not assume that your crystal is an A-T cut just because it is a "low drift" cut. Not all low-drift crystals are A-T cut.

Do not become alarmed if the oscillator will not key well when lighting up a 40 watt Mazda lamp. There is a very great change in the resistance of the lamp when it is hot, and this change may give rise to a "yooping" effect during keying. In fact, when the key is up and the lamp goes out, the resistance may drop so much that there is too much of a load on the oscillator for it to start the next time the key is pressed.

The 6L6's will draw from 150 to 200 ma. on 40 meters.

20 Meters

With the coils in position for 20 meters (refer to table) and neither key nor meter in J_3, tune C_6 for maximum output as indicated on a flashlamp and pickup loop coupled to coil no. 1, making sure the condenser is not set too close to the "edge" of oscillation. Close J_3 with either the meter or key (in the latter event, the meter goes in J_4) and tune C_{12} for the resonance dip. Couple the load to the tank and increase the loading until there is just a barely perceptible dip at resonance. Go back and touch up C_6 for maximum output from the 6L6 stage. The 6L6's are then delivering maximum output. The plate-and-screen current will run around 165 ma. under these conditions if the designated voltage of 525-550 is used. Incidentally, not all of this voltage is impressed upon the 6L6's, as there is a voltage drop across the cathode resistor.

10 Meters

For 10 meters, put the coils in their proper positions, throw the bandswitch to "10" or "28", and with J_3 open apply the plate voltage. Tune coil 1 for maximum output as indicated on the flashlamp. Repeat with coil 2. Tune the 6L6's the same as on 20 meters, loading them up till there is just barely a dip at resonance. Go back and touch up C_2 and C_6 for maximum output from the 6L6's as indicated by the flashlamp coupled to the 10 meter output coil.

The plate voltage on the 6A6's is so low that it is not necessary to read their plate current; all that is necessary is to tune them for maximum output. The off-resonance plate current is automatically limited by the dropping resistors, R_2 and R_5, making it impossible to exceed the plate dissipation of the 6A6's. However, if you are curious, the plate current can be measured by inserting the meter in J_1 and J_2.

20 Meter Phone

Because no buffer stage is used, it is necessary when using the outfit for 20 meter phone to back off the oscillator slightly from maximum output for the sake of stability. The 6L6's require such a small amount of drive that the oscillator is very lightly loaded. This, coupled

[*Continued on Page 84*]

Simplified Adjustment of the "Q" Antenna System

By "Jayenay"

A great many requests for a description of a simple step-by-step procedure for determining proper spacing of the Q bars have been received.

The apparent complexity of the Q antenna system comes from the large number of antenna and line combinations which the Q section is able to match. By eliminating all but the most common combinations all the spacing data can be placed in one simple table.

The length of the flat top or radiating portion of the half-wave Q-fed antenna equals 468 divided by the frequency in *megacycles*. The answer is in feet. The length of the Q bars will be exactly half the total length of the flat-top radiator, or 234 divided by the frequency in *megacycles*. The formulas are shown in the diagram.

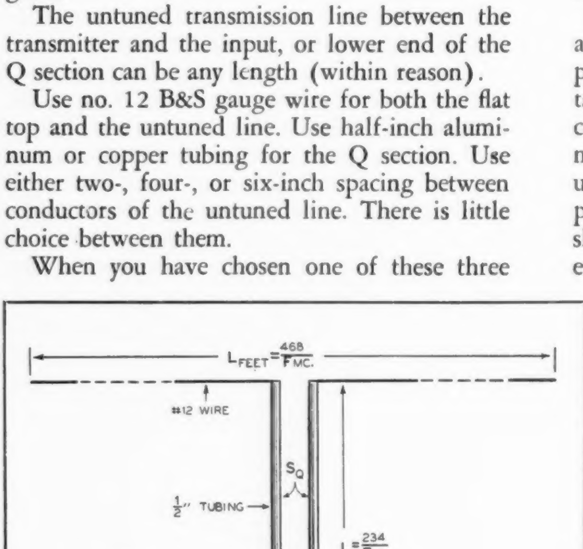
The untuned transmission line between the transmitter and the input, or lower end of the Q section can be any length (within reason).

Use no. 12 B&S gauge wire for both the flat top and the untuned line. Use half-inch aluminum or copper tubing for the Q section. Use either two-, four-, or six-inch spacing between conductors of the untuned line. There is little choice between them.

When you have chosen one of these three untuned line spacings, pick it out on the accompanying table, and opposite it you will find the proper center-to-center spacing of the Q bars. Subtract one-half inch from the center-to-center spacing and you will get approximately the outside-to-outside spacing of the Q bars. The regular Q antenna kit includes a spacing tool calibrated in center-to-center spacings.

Construct the antenna and feeder assembly and do a good mechanical job, with all joints soldered. Install the radiator as high as possible and see that radiator length, Q section length, Q section spacing, and untuned line spacing all are what they should be. The Q bar diameter must be a half-inch and the wire size for the untuned line must be no. 12 for the table to be operative.

Couple the line to the plate tank of the final amplifier in any of the conventional ways. It is perfectly permissible to tap the line on the plate tank coil equal distances each side of the coil center tap. Starting close to the center tap, move the feeder taps farther out on each side until either the final amplifier draws normal plate current, or until the final amplifier tubes show signs of excessive plate dissipation, whichever limit occurs first.



It is highly desirable to place series blocking condensers in each side of the line close to the transmitter to keep high-voltage direct current off the feeder and antenna system. These blocking condensers can consist of mica .002 μfd. high-voltage fixed condensers.

No extensive or complicated impedance-matching networks are necessary at the station end of the untuned transmission line unless you are troubled with a bad third harmonic which you want to reduce. The important impedance matching in the Q antenna system, as in all matched-impedance antenna systems, takes place between the antenna and the untuned line. If the Q bar spacing is not correct for the untuned line spacing used, no amount of adjustment at the transmitter end of the untuned line will reduce the undesired standing waves on the untuned line.

SPACING UNTUNED LINE	SPACING Q BARS
2"	1 3/16
4"	1 3/8
6"	1 7/16

Table of spacing for half-wave Q antenna system using no. 12 wire in untuned line and half-inch Q bars. Spacings given are center-to-center.

The values in the table are based upon the assumption that the impedance at the center of the radiator is 75 ohms. If, due to proximity to ground or surrounding objects, the surge impedance is much higher or lower than this value, the figures given will not be exactly right, though they are a good place from which to "start". As a check, run a neon bulb along one feeder of the untuned feed line for about an eighth wave. There probably will be no variation in brilliancy if the system is cut and adjusted to the figures given in the formula and table. However, if "bumps" should be apparent, it will be necessary to make slight adjustment in the spacing of the Q bars in order to remove completely the standing waves.

It is quite easy to tell whether the bars should be moved closer together or further apart if the junction of the Q bars and untuned feeder is accessible. If, as the neon bulb is run along the untuned feeder away from the junction of feeder and Q bars the bulb gets *brighter,* the Q bars should be spaced a little *wider apart.* If the neon bulb gets *dimmer* as you run it along the open line away from the junction of the Q bars, the Q bars should be spaced slightly *closer together.*

THE QUESTION BOX

Will you describe in a few simple words the fundamental conception behind logarithims? Logarithmic scales of frequency and amplitude (decibels) are being widely used in radio and sound applications.

Logarithmic functions and scales deal with relative proportions while arithmetic functions deal with absolute quantities. Thus an arithmetic scale would be 1, 2, 3, 4, 5, 6, 7, etc. It is obvious that the increment between 6 and 7 is the same as the increment between 2 and 3, although proportionately it is a much smaller percentage.

In the logarithmic scale equal distances along the scale would be 1, 2, 4, 8, 16, 32, etc. Thus the increment between any two points on the scale always represents the same proportion.

The human senses, including sight and hearing, respond to relative, or proportionate changes in stimulus rather than to absolute changes; and thus when dealing with equipment designed to present stimuli to the human senses, it is necessary to define certain performance characteristics in logarithmic terms.

Which type of cathode ray 'scope figure is most useful for modulation monitoring, the linear sweep or the trapezoid?

For transmitter lineup with an audio oscillator I prefer the linear sweep. For continuous monitoring of voice and other complex and discontinuous waveforms, I prefer the phase shift figure over either the linear sweep or the trapezoid. In the phase shift, or circle pattern, the indication of overmodulation always appears at the same point on the cathode ray tube, which is not true of the other patterns. The phase shift figure also is the simplest figure to obtain, as only one wire carrying r.f. from the transmitter output is necessary to get the pattern. R.f. is applied to both sets of plates. See the R.C.A. cathode ray handbook for further data.

I notice on the newer receiving tube tables a sudden new group of 2 volt tubes which has appeared unheralded. Can you give me a hint as to their construction and purpose?

I presume you refer to the group whose designations always start with the digit 1 and always end with the letter G, such as the 1H4G. These new two-volt low-drain tubes are practically identical with the newer of the standard two volt tubes, both electrically and mechanically, except for the use of the octal base. Thus the 1H4G is nothing but our old friend the type 30 triode with a new base. The group includes a medium μ and a low μ triode; a low μ and a high μ twin triode; a variable μ and a fixed μ multigrid screened amplifier tube; a duo diode screened pentode and an audio output pentode. The group also includes a twin audio pentode and a combination oscillator-mixer tube. It also includes a duo diode triode. None of these tubes has appeared in the metal envelopes as yet, although the public demand for metal tubes may force the manufacturers to put the two volt tubes into tin cans the same as beer.

When the coupling between primary and secondary of an i.f. transformer is reduced to increase the selectivity, what is the effect upon the gain or step-up in voltage of the transformer? Both primary and secondary windings are tuned.

Most conventional i.f. transformers available on the open market are overcoupled in order to approximate "square topped" response. Thus, reducing the coupling will increase both the selectivity and gain up to a certain point, where the selectivity will stop increasing and the gain will start to decrease. Often the gain will increase so much with a reduction in coupling that the i.f. amplifier will start to oscillate. I have never seen a two-stage i.f. amplifier operate with optimum coupling for maximum selectivity and gain without oscillation at normal tube voltages.

Reducing Harmonic Radiation

By Ray L. Dawley, W6DHG

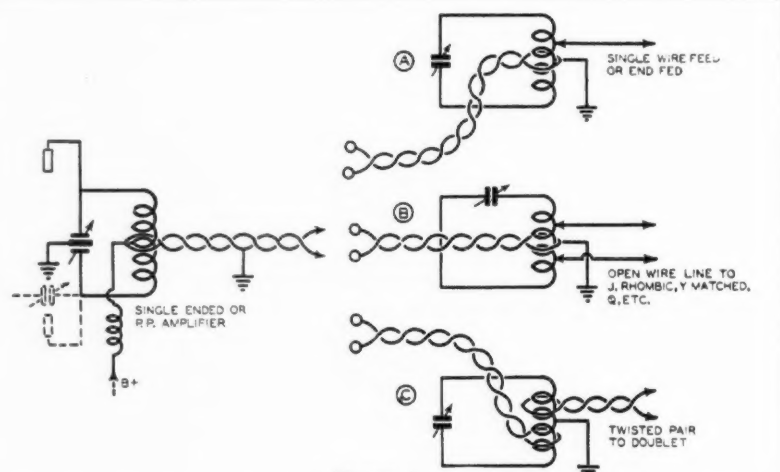


Figure 1

In the past few years, what with the greatly increased number of amateurs and the much more general use of high power, the harmonic radiation problem has been greatly intensified. Other outstanding contributory causes have been the more widespread use of twisted-pair doublets, so-called π-matching networks, and heavily excited, high impedance tubes running with high bias and low-C plate tanks. In the majority of cases of harmonic radiation from the high power c.w. hams, the latter condition has caused more than its share of the trouble.

To look at the problem from a standpoint of reason, three definite conditions must exist in the transmitter before harmonic radiation can take place. First, the final amplifier must either be generating or amplifying the undesired harmonics; second, the coupling system between the amplifier and the feeders or antenna system must be capable of transmitting them; and third, the antenna system (or its feeders) must be capable of radiating this harmonic energy.

To consider the first point in detail, we must consider the various factors that can cause a harmonic to exist in the output of the final amplifier. In the majority of cases where a harmonic is being found, the chances are very good that it is being generated in the final amplifier. This is especially true when link coupling is employed between the last buffer and the final stage. If the link is grounded to eliminate capacity coupling, and fairly loose inductive coupling is used between the link and the two tank circuits concerned, very little if any harmonic energy will be transferred to the grid circuit of the final. Since most of the selectivity against the transfer of harmonics is being offered by the final amplifier grid circuit, it is advisable to make this circuit as high-C, and consequently high-Q, as practicable.

Capacity coupling between the buffer and final is undesirable from a harmonic transfer standpoint, inasmuch as there is no discrimination introduced by the coupling condenser.

Then, assuming that steps have been taken to eliminate the coupling in of harmonics to the grid circuit, all that exist are being generated in the final tubes themselves. A well-balanced push-pull amplifier with matched tubes and symmetrical grid and plate circuits will very nearly cancel all second harmonic produced. Since, however, a push-pull stage has no discrimination against the third harmonic, the tubes should work into as high-Q a plate tank as is possible under the conditions of operation desired. Numerous charts and tables have been published to aid in the proper design of the plate tank.

A single-ended amplifier is another and much more difficult problem. Since there is no cancellation of the second harmonic, the only way of attenuating the harmonic energy within the amplifier itself is through the use of a high-Q plate tank.

Coupling Systems

Now, if the amplifier is operating so that it generates a minimum of harmonic energy, we can take steps to minimize the coupling of this

energy to the antenna system. Second harmonic coupling can be reduced by a number of quite satisfactory methods.

In a majority of cases when an antenna system is coupled to a transmitter it is being fed current at this point. When the same system is operated on the second harmonic it would have to be fed voltage at the same point. This fact can be proven, by a little reflection on the matter, to be true in the case of most zepps. operating on the fundamental or integral harmonics, "Q"-fed systems, and line-fed arrangements of either the twisted pair or open wire type. Now, inasmuch as the antenna system in most cases must be fed voltage at the ends of the feeders, for even harmonic operation, if we can eliminate capacity coupling at this point, the second and other even harmonics will be attenuated. An excellent method of reducing capacity coupling is through the use of a Faraday shield. The Faraday shield, however, offers no attenuation to anything but *capacity coupling* of the undesired energy. Since a great deal of the harmonic energy (the third and other odd harmonics) is *inductively* coupled to the antenna system, an arrangement which will attenuate both capacitively and inductively coupled harmonics (both odd and even) would be desirable. A Faraday shield is not a "cure-all."

A suggestion for such an arrangement is shown in figure 1. The link from the final tank to the antenna tank should consist of either a length of low-impedance cable (EO-1 or similar) or a *closely spaced* line of no. 12 or larger wire. This link should be loosely coupled by means of a single turn at either end to both tank circuits. One side of the link should be effectively grounded near the final tank. The antenna tank itself should be of medium C (a Q of about 10 or 12) at the operating frequency. At figure 1c, the two links, the one to the final and the one to the antenna, should be spaced about two inches or so apart and at equal distances from the grounded center of the antenna coil. The balance of the diagram should be self-explanatory.

This coupling system operates by virtue of the fact that capacity coupling between the final tank and the antenna is eliminated by the grounded link and the grounded center-tap of the antenna tank; also, due to the selectivity of the antenna tank against the harmonic frequencies, inductive coupling of them into the antenna system will also be attenuated.

Antennas

It stands to reason that if an antenna is a good radiator of both the fundamental and its harmonics (for example, if it will operate well on 80, 40, 20, etc.) it will offer no discrimination, in itself, against the radiation of these harmonics. Since the zepp. and single-wire-fed antennas are outstanding in this respect, if harmonic radiation difficulties are being experienced with these radiators even after proper precautions (as described before) have been taken, the best expedient is to change the type of antenna system. The "J" antenna (as described elsewhere in this issue), a Johnson "Q", a *delta* matched doublet—in fact any antenna which works well on only one band will be a worthwhile improvement. If this change is made, the coupling system shown in figure 1b would be best.

If, after taking these precautions, some harmonic radiation still exists, it can be further attenuated by means of an absorption circuit inductively coupled to the final tank, by a link if you wish. A suitable coil and midget condenser to tune to the interfering harmonic, loaded with an appropriate lamp or bank of non-inductive resistors to dissipate the energy, the whole system tightly coupled to the final tank, will effect a reduction in the harmonic energy that is radiated.

In closing, a few general don'ts might be in order:

Don't use two tubes in parallel. Put them in push-pull if possible.

Don't use a doubler to feed an antenna unless it is of the push-push type. In a single-ended doubler, there is a high percentage of half and three-times frequency present in the output tank.

Don't use more bias and excitation than necessary for reasonable efficiency or (in a phone transmitter) good linearity.

Don't use a 75 meter zepp. on 160 meters, a 40 meter zepp. on 80 meters, etc. Although it is usually the odd harmonics that are inductively coupled, in this case the second harmonic will be inductively coupled, and elimination of capacity coupling will not remove the second harmonic.

Don't use an "all band" antenna unless you do not have room for separate antennas. If you must use such an antenna, use a harmonic-attenuating tank as shown in the accompanying diagrams.

Don't wait till you get a ticket for interfering with other services. Run a test with some local amateur close enough to give you an accurate check, and see if your harmonics are objectionable.

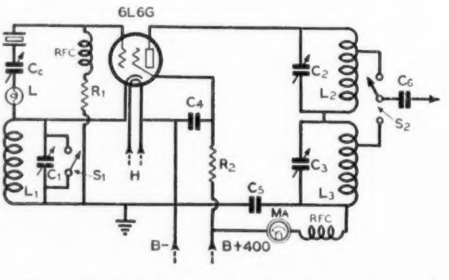
Taming the "Tri-Tet"

By CARL YOUNG,* W2KL

With the development of the so-called "tri-tet" power oscillator introduced to amateur radio several years ago, there arose a widespread cry regarding its revolutionary performance. Its vastly superior harmonic generating qualities with consequent greater output and plate efficiency on these harmonics made it truly a topic for discussion. This ballyhoo, however, quickly died when cautious and fore-sighted experimenters dared to measure the r.f. current flowing through their pet crystals, especially 40 meter crystals. About this time the incautious began to find their crystals badly overheating, frequently shattering and chipping, and almost always drifting a tremendous amount during periods of operation. Thus the renowned 59 tri-tet died a more or less natural death except with those few using 160 meter or the rugged AT type of crystal. The above remarks refer most specifically to the *power* circuit using tubes with a plate voltage of 400 or over.

Recently, with the development of the now famous 6L6 and 6L6G tubes, the old ballyhoo returned. Here was a tube capable of furnishing tremendous output when used in either the tritet or the conventional crystal oscillator circuit. Great possibilities were forecast, a few of them realized; but alas, the old bugaboo still existed. Crystal current was abnormally high with any circuit used.

The writer was tempted to experiment along these lines and became highly elated until the crystal current was measured. This was found to be sky high and greatly in excess of the safe operating current for 80 and 40 meter crystals. Then began a period of endeavoring to figure a means whereby the 6L6 tri-tet advantages could be utilized without crystal worries. The question: "Could crystal current be reduced to a normal operating value without materially decreasing the output?" The answer, from experiment: "Yes, it could." The circuit differs primarily from the regulation tri-tet in that a small series variable condenser (controlling condenser) is employed in the crystal-cathode tank lead. The cathode circuit differs somewhat from



The Controlled Tritet, 40 Meter Crystal

C_C—50 or 100 μμfd. midget
C_1—140 μμfd. midget
C_2—140 μμfd. midget
C_3—75 μμfd. midget
C_4, C_5—.003 μfd. mica
C_6—.0001 μfd. mica
R_1—250,000 ohms, 1 watt
R_2—25,000 ohms, 10 watts
L_1—8 turns no. 18, spaced, 2" dia.
L_2—7 Mc., 15 turns no. 18, 2" dia. 14 Mc., 7 turns no. 18, 2" dia.
L_3—28 Mc., 3 turns no. 18, 2" dia.
Note—L_3 is used with 14 Mc. coil at L_2
S_1—Cathode circuit shorting switch
S_2—Band change sw.
L—60 or 150 ma. lamp

the popular arrangement as explained later in the article.

It appears, from varied tests and much experimenting, that a great deal of the feedback evident is superfluous and serves no useful purpose. This point was proven by reducing the crystal current to approximately one-fifth its original value with no decrease in output energy as measured by the grid meter on the following stage. In other words, the crystal current on an active 40 meter X-cut crystal was reduced from a high value of approximately 150 ma. to a mere 20 to 30 ma. This latter value is, of course, far below the maximum safe operating current for a crystal of this type.

If it is desired to check the crystal current with a thermo-galvanometer, care must be taken in keeping the leads to the instrument very short and well separated. If this is not done, it is possible that a great deal of the grid r.f. will be by-passed by the lead capacity. This will of course result in a false low reading on the galvanometer. For those not having a thermo-galvanometer available, a 150 ma. (or better, a 60 ma.) bulb in the grid circuit will serve as a rough check.

A few remarks regarding the peculiarities and adjustments of this arrangement may prove helpful. The best method of adjusting the con-

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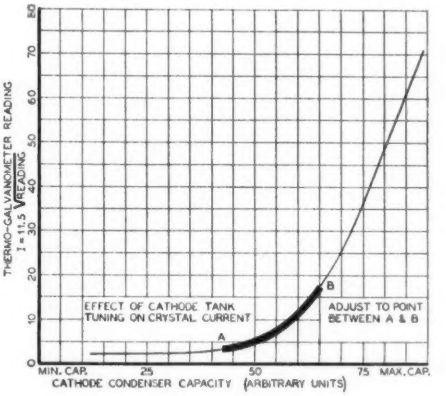
trolling condenser seems to be: first, decrease its capacity until the crystal acts unstable and is slow in starting; second, increase the capacity from this point until the crystal oscillates stably as evidenced by instantaneous start upon application of the plate voltage. This will be the point of lowest crystal current with normal output. With the controlling capacity reduced to a minimum value, the circuit may show tendencies to oscillate by itself, "without benefit of crystal". This tendency, however, completely disappears and the crystal takes control when the capacity is increased.

With the cathode coil shorted and the 7 Mc. fundamental plate coil in place, the same satisfying results are obtained. With a decrease in feedback, the crystal current is greatly reduced and there is no noticeable fall-off in the power output. There is, however, a slight increase in the plate current on the 6L6 due to the reduced excitation voltage.

Care should be exercised in the design of the cathode circuit if best results are to be obtained. The cathode coil shown gives complete control over the oscillation of a crystal in the 7 Mc. band. At near maximum capacity the crystal current will rise to a very high value. Past this point, oscillation will cease. Tuning in the other direction, the crystal current drops somewhat near minimum capacity but oscillation becomes erratic and difficult to start. The correct setting lies between these two points, where good stability with low r.f. crystal current will be obtained. This adjustment, however, is not of a critical nature. It is shown graphically by the chart of figure 2. If desired, by the cut-and-try method a cathode coil can be wound which will give the correct amount of regeneration over the 7 Mc. band without the use of the cathode tuning condenser.

Two forty-meter X-cut crystals were used in conducting these tests. Both were strong oscillators and their frequencies were at opposite ends of the 7 Mc. band. The controlling condenser was set to about half maximum capacity for second and fourth harmonic operation and reduced to near the minimum value for operation on the fundamental. Of course, for fundamental operation, the cathode coil shorting switch, SW, must be closed. In instances where less active high-frequency or the usual low-frequency crystals are employed, it may be found that the capacity of the controlling condenser will have to be increased to allow for proper adjustment of the feedback. A maximum value



of 100 μμfd. will be satisfactory in these cases.

Thus, with the application of the controlling condenser and the correctly designed cathode circuit, we have approached the ideal operating conditions for a crystal oscillator: very low crystal current with real output on the fundamental and the second and fourth harmonics.

Another, though less general, application of this arrangement would be in the practical use of 14 Mc. crystals. With the oscillator set up in this manner, very respectable output would be obtainable on 56 Mc. without endangering the crystal.

◆

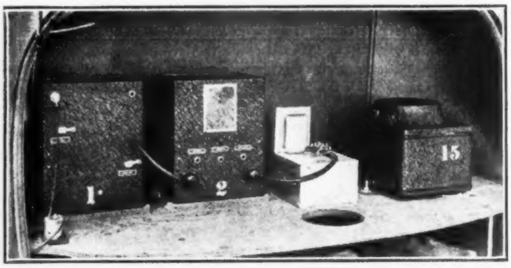
Spanish War Rebroadcast

On February 24th, W3GLV heard two transmitters on frequencies of about 40 and 44 Mc. operated from the Spanish war zone. Gunfire was audible on both signals. The operators, talking in Spanish, mentioned positions and supplies. The carriers were d.c. until modulated, when frequency modulation was present but did not affect reception on the regenerative (not super-regenerative) receiver in use at W3GLV. The signals got up to R9 at times. The reception was between 11 a.m. and 12:45 p.m., E.s.t.

We are still plugging for a small band at 42 Mc.!

◆

The March issue of the *American Magazine* features W9HQ, John N. Becker of Chicago, in its "America's Interesting People" department. A large rotogravure picture shows him at the controls at his job of Chief Dispatcher at the Chicago municipal airport. He listens to 13 radio receivers and runs an appropriate number of transmitters at this busy airport which clears 75,000 planes yearly. He has hamming and astronomy as hobbies when off work.



Ten Meter Mobile Crystal Control

By George M. Grening*

With the present interest in the ten-meter band and the good conditions now prevalent, more and more amateurs are thinking of operating mobile in this band. For those who are used to five meters for local work, ten meters is a revelation as regards the almost complete absence of dead spots and the ability to work over hills. Add to this the fact that good dx is usually possible, and you find that the amateur ten-meter band is ideal for mobile communication.

While self-excited oscillators and m.o.p.a.'s give excellent results when a super-regenerative receiver is used, the more advanced ten-meter station, you find, is equipped with a late model superhet which takes in this band. Modulated oscillators and most m.o.p.a.'s are unreadable on this type of receiver. The obvious remedy is crystal control, not a particularly easy problem to solve in a mobile transmitter.

It is the purpose of this article to describe a successful, inexpensive ten-meter car transmitter of reasonable power output, which has withstood the most severe police service possible.

If greater power is desired at a fixed station, it makes an excellent exciter for a high-power stage. Its eight to ten watt output into a good antenna, however, will allow plenty of dx.

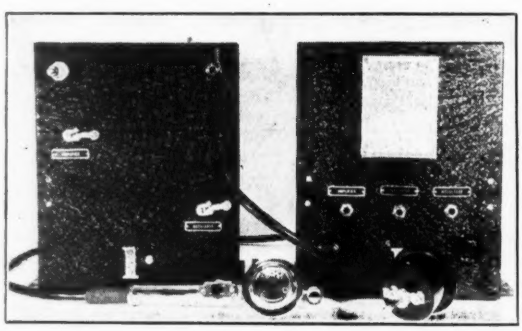
The basis of this transmitter is the popular 6A6 tube, since one section of this double triode may be used as an oscillator and the other as a multiplier. Raytheon's special ultra-high frequency tube, the RK-34, may also be used and is slightly easier to drive as an amplifier. The ceramic base 6A6's made by the same concern are superior to the bakelite base type and should be used if maximum results are to be obtained.

As is usual with ultra-high frequency equipment, all r.f. leads should be as short as possible. This has been followed in the transmitter illustrated. While its appearance may suffer, the "shortest distance between two points" is still a straight line.

A transmitter using an almost identical circuit, developed independently by the Pasadena Police Department, has successfully worked the first, ninth, and K6 districts in addition to working many stations classified as local, all from a car. The circuit is a conversion of the ten-meter m.o.p.a. described in June, 1936, Radio.

Mechanical Construction

The placement of parts is not at all critical as long as r.f. leads are short. For example: all ten-meter coils are soldered directly on their condensers. The oscillator-to-multiplier coupling condenser has one end soldered on the oscillator coil and the other directly to the grid terminal of the multiplier. The exciter and push-pull amplifier are mounted back to back, with the exciter in the upside down position. While this

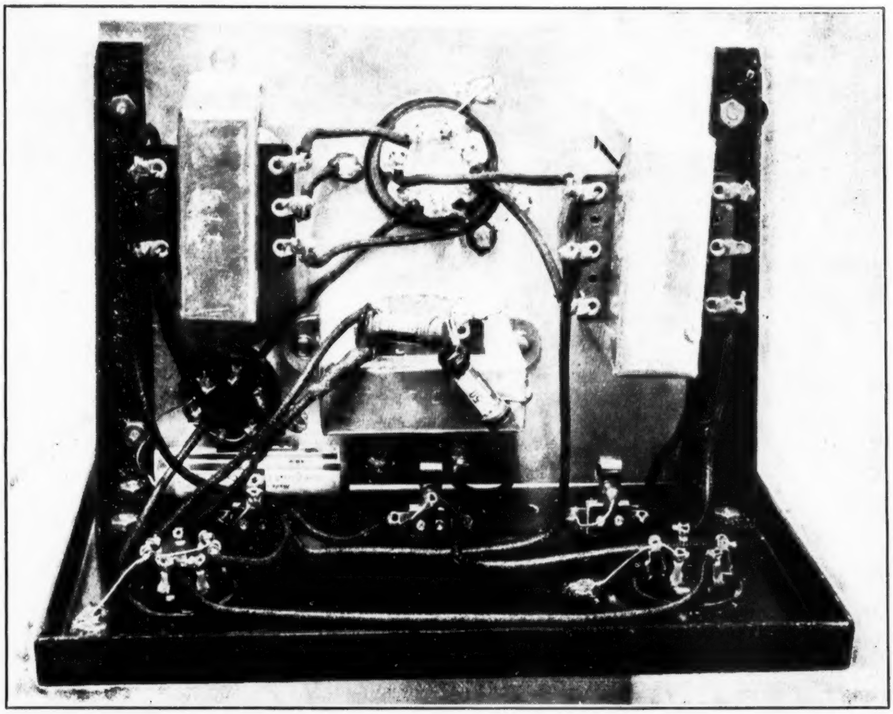


The Complete Transmitter, Mike, and Plug-in Meter

assists in short leads, other mechanical arrangements are possible.

All tuning condensers have their shafts locked with National type R.S.L. rotor locks. The multiplier and final amplifier condensers have shaft extensions extending through the front panel to facilitate final tuning in the car. This is not necessary with the oscillator tank condenser.

*Police Dept., Santa Barbara, Calif.



Bottom View of the Modulator. The 7-Prong Socket Takes a 6A6, Which Was Later Replaced With a 79, Which Draws Less Static Current

C_2 and C_3 must be insulated from ground, while C_6 has its rotor grounded. L_1 is wound on an ordinary broadcast receiver coil form. Ceramic materials did not increase the output. The balance of the coils are air wound and have strips of celluloid cemented on them with Duco household cement, for rigidity in mobile service. Equal efficiency seems to be obtained if these latter coils are wound on ceramic tubing of ¾ inch outside diameter.

The index to the efficiency of any harmonic generator or exciter lies in the grid milliammeter of the final stage. Anything that will give maximum grid current in that stage is worth incorporating. The following adjustments fulfill that condition in the set illustrated.

C_2, it will be noted, is a 100 μμfd. condenser. L_1 should be adjusted until C_2 is almost all the way in. With a milliammeter reading the combined plate current of the oscillator and quadrupler, adjust C_2 to the point of lowest plate current consistent with instantaneous starting of the crystal when the plate voltage is switched on and off.

While experimenting, it was found that the higher the capacity of C_2, up to a value of 100 μμfd., the greater the fourth harmonic output. The output of the forty-meter crystal is fed through a .002 μfd. condenser to the second section of the 6A6.

No resistor is used across the crystal. If one is put in, the output drops. No cathode resistor is used for the same reason. The r.f. choke across the crystal should be a type which gives the lowest plate current. It is worth experimenting with different types in this position, as it was found that certain types gave an exceptionally high plate current. The more active the crystal, the greater the output.

The plate circuit of the second section is tuned to the fourth harmonic of the oscillator, a rather unusual procedure. The grid r.f. choke in this stage is rather critical and again different types should be tried. The best choke in the transmitter shown was found to be an Ohmite high-frequency choke, which has the appearance of a resistor unless one looks very closely.

The grid bias resistor on the quadrupler is not extremely critical. The value given, however, performs slightly better than others tried.

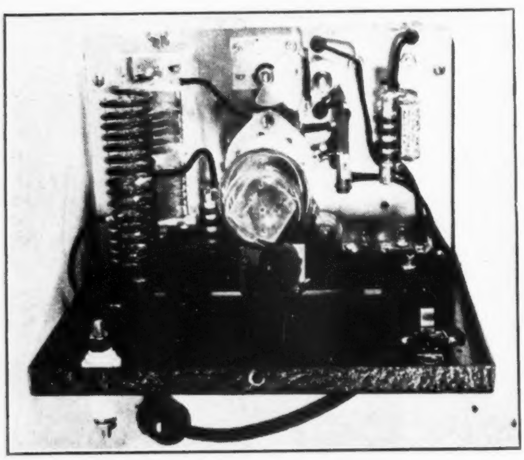
The tank circuit composed of L_2, C_3 must be tuned to the fourth harmonic of the crystal, or the ten-meter band. Don't do as we did and find that you are on 8 or 13 meters.

If an absorption wavetrap is not available, tune a super regenerative receiver to the ten-meter band and, holding the detector coil near L_2, C_3, see if it stops the hiss as C_3 is rotated. If not, prune the coil.

The grid coil of the final is closely coupled to the plate tank of the quadrupler and must be wound with special care. Starting with plenty of turns, clip off a turn at a time until the grid current in the final reaches maximum. This coil is critical to within one turn or less. Be absolutely sure it is right or poor results will be obtained.

If too lazy to go to this trouble, shunt a split stator condenser across a coil using fewer turns and tune it thus. The fixed grid type, however, gives better efficiency.

The final stage may also be link coupled with equal results. Use a two-turn link around the B plus end of L_2 and a two-turn link around the center of L_3.



Top Deck of the R.F. Unit, Showing the 6A6 Push-Pull Amplifier

The 6A6 push-pull amplifier is straightforward and should present no difficulty. Cross-neutralization is used and, with the condensers indicated, this stage neutralizes perfectly with the plates about a quarter meshed. Neutralize by the grid dip method.

The only precaution to be observed in the final is the obvious one of having L_4, C_6 tune to the output frequency.

The final stage should be loaded by the antenna to 50 ma. This stage will operate efficiently with as little as six ma. of grid current. The usual value obtained lies between ten and fifteen with a 6A6 and slightly more with an RK-34.

The modulator consists of a 6C6 connected as a triode. A 76 may also be used. The 89 class B stage is conventional in all respects. This was substituted for a 6A6 first used, because of lower static current. With a single- or double-button hand microphone having 3 volts on it, the 15 watt input to the final is 100 per cent modulated.

PLATE CURRENTS

Speech and modulator (resting)....17 ma.
Comb. oscillator and quadrupler 50 ma. or less
Final amplifier, no load................16 ma.
Final amplifier, loaded..................50 ma.
Grid current to final............12 to 15 ma.

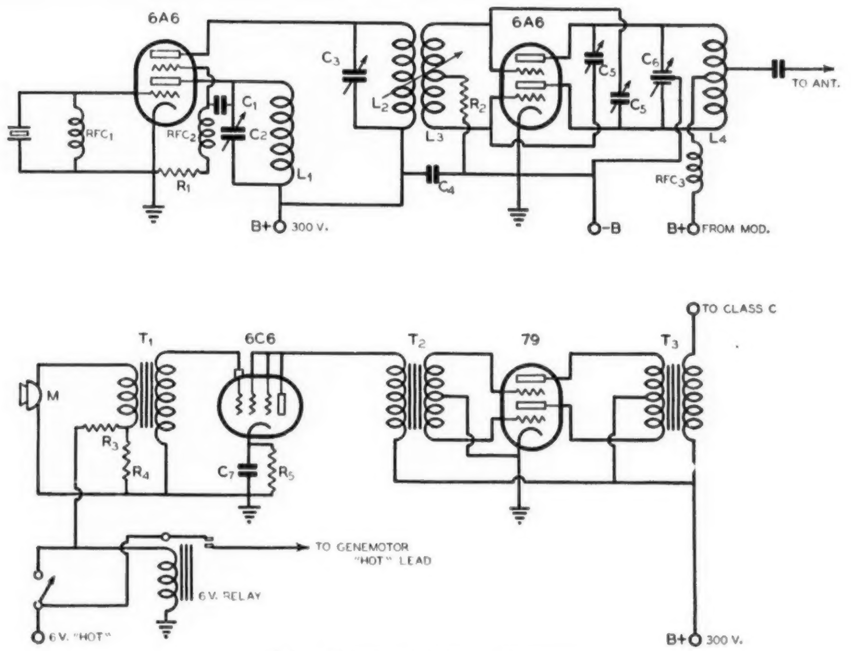
Obtained wtih a generator voltage of 280 to 300 volts

A midget class B output transformer designed to work into an r.f. load of 5000 or 6000 ohms will give a quality which is only limited by the type of single-button mike used.

A word as to power supply for mobile operation: the total drain of the set, including modulator, is in the neighborhood of 115 ma. If you can't afford a 300-volt, 150 ma. generator, the reasonably priced 100 ma. type will deliver 280 volts under this load without damage to it. It is imperative, however, that no. 6 or 8 cable be run from the battery to the generator.

Another alternative is to connect two generators or the newer 300-volt, 100 ma. vibrators in parallel. This increases the battery drain and since the transmitter works satisfactorily with but one generator, there is little need for two. The regulation of the vibrator type, when the current drain on it exceeds 100 ma., precludes its use alone.

This transmitter may be set up in a fixed location by means of a power supply similar to the one illustrated, which is quite orthodox. A transformer which will deliver around 375 volts under full load should be used. With a choke input single-section filter and 83 or 5Z3 rectifier, humless operation is possible. This particular power supply contains a 4.5 volt mike battery, the microphone plugging into the front panel. This power supply is connected to the transmitter by a plug-in cable.



The General Wiring Diagram

C_1—.002 µfd. mica
C_2—100 µµfd. midget
C_3—35 µµfd. midget
C_4—.01 µfd. mica
C_5—15 µµfd. midget
C_6—35 µµfd. per section, single spaced
C_7—10 µfd., 25 volt tubular
R_1—100,000 ohms, 2 watt
R_2—2000 ohms, 3 watt
R_3, R_4—50 ohms, 3 watt
R_5—2500 ohms, 1 watt
RFC_1—2½ mh., 125 ma. choke
RFC_2—High frequency choke
RFC_3—2½ mh., 125 ma. choke
T_1—Single button mike to grid
T_2—Class B input transformer
T_3—Class B output to 5000 ohms
M—Single button hand mike

Coil values for 28 Mc.:
L_1—12 turns no. 18, 1″ form
L_2—12 turns no. 10, ¾″ i.d., 3″ long
L_3—24 turns no. 10, ¾″ i.d., 3″ long
L_4—19 turns no. 10, ¾″ i.d., 3″ long

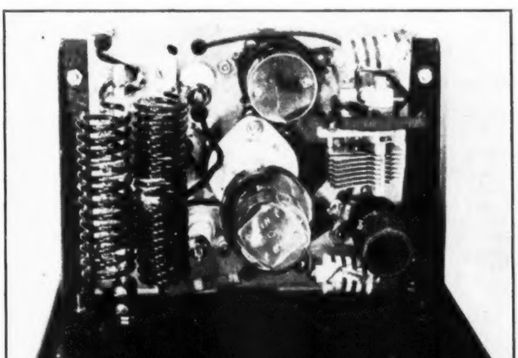
Coil values for 30.1 Mc.:
L_1—9 turns no. 18, 1″ form
L_2—10 turns no. 10, ¾″ i.d., 3″ long
L_3—21 turns no. 10, ¾″ i.d., 3″ long
L_4—15 turns no. 10, ¾″ i.d., 3″ long

All filament and plate voltages are brought out to a terminal strip in the back as well, to be used in operating a small receiver or for general utility testing purposes.

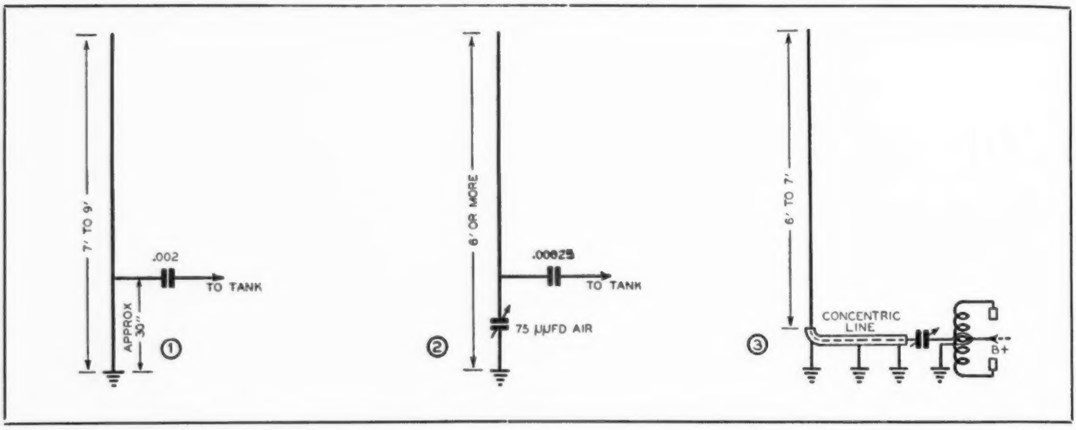
The Antenna

No mobile transmitter is any better than its antenna. Half-wave Hertz antennas are too long to be used on a car; therefore, the Marconi type is a necessity.

Probably the most successful type is one of the new broadcast receiver fishpoles, extended to its full height and grounded to the car chassis at its base. The single-wire feeder taps on approximately a third of the way up from the base, although the exact point is not critical. This is coupled to the final tank coil through a fixed condenser. The final stage is loaded to 50 ma. by varying the position of this tap. This



Bottom Deck of the R.F. Unit (6A6 Exciter)



type has worked across the continent numerous times.

Where antenna height is a big consideration, the following two unorthodox types have given good results with a six-foot fishpole.

In the first type (antenna "2") the 75 μμfd. condenser is varied to give *minimum* plate current on the final. Retune the final tank condenser after each change. The final again should be loaded to 50 ma. by varying the tap.

The second type (antenna "3") more nearly approaches the results of the higher antennas (antenna "1"). A concentric transmission line is constructed by threading spark plug cable having a no. 12 or 14 conductor through the shielded loom used on broadcast automobile antenna lead-ins. For the short run necessary, the loss in this type is not serious.

A one-turn link goes around the center of the final tank coil, with one end grounded to the chassis and the other coming to the feed-through insulator. A 75 μμfd. trimmer is mounted in such a manner that it can be easily tuned.

While it is rather questionable as to whether this type actually acts as a concentric line, a comparison with a true coaxial line-fed antenna shows no difference in field strength. The transmission line should be well-grounded at the base of the antenna and where the shielding ends at the set panel. It can be strapped to the car chassis on its run into the car, since the loom is at ground potential throughout its length.

The condenser is tuned to load the final to a maximum, returning the final tank condenser after each change, and the one-turn coupling link is made larger in diameter until the final is loaded to 50 ma. Very loose coupling is possible. This type gives excellent results. All of these antennas when mounted on the rear bumper are slightly prone to transmit best in the direction in which the car is pointing.

A simple self-quenched super-regenerative receiver in the car, using a 6C5 oscillator and a 6C5-6F6 audio system, gives trans-continental loudspeaker reception with the car in motion.

The approximate cost of the transmitter illustrated, completely installed in a car and including tubes, generator, microphone, antenna, and crystal, runs around $85.00. No doubt the junk box would yield many parts.

Two of these rigs, one in a car and the other in the station, make an excellent two-way police communications system for the small town. The cost should not run more than $250, including receivers and installation.

With the type of set illustrated, we work our cars for 30 miles consistently and up to 60 miles intermittently. Local coverage is absolutely perfect with not a single dead spot. Under favorable conditions, dx is a real possibility.

◆

Mexico Cancels Licenses of Foreigners

B. J. Kroger, now YN1BJ but who up until recently has held the call XE1AY—so well known on the higher frequency bands—tells us that Mexico has cancelled all radio licenses held by foreigners.

This action is not at all out of line with our policy here in the U.S., where aliens cannot hold a "ticket". We know of one chap who grew up here but whose Canadian father never did take out final papers. It meant an enforced period "off the air". We feel that it is generally better to license aliens and know who and where they are, rather than to refuse such licenses and hope for the best!

28 and 56 Megacycle Activity

By E. H. Conklin, W9FM

CN8MQ reported via G2YL that on January 3 he heard PA0ZB RST576 at 10.30 G.m.t. on five meters; D4KPJ RST449 at 10.40; D4VDV RST339 at 12.30; and many weaker signals. On January 4, he heard G6XI RST339 at 10.00 G.m.t. and a number of commercial harmonics around 56 Mc. Also on December 27 when G5BY was heard by M2HXD, CN8MQ heard harmonics of PA0KW and PA0UN.

We were glad to note that W4EF has heard both code and phone 56 Mc. signals from the west coast on the receiver described in the March issue. We wonder what some of the successful G's are using. With better receivers, more can be accomplished. Even Lloyd Jones of W6DOB, who has heard all districts on 56 Mc., has built a new and improved receiver using a 6K7 r.f. tube; 6J7 mixer; 6J7 oscillator; two 6K7's in the 5 Mc. intermediate frequency amplifier; 6H6 detector and noise suppressor; 6C5 audio and 6C5 beat oscillator. The coils are soldered right on the condensers. The r.f. and mixer stages are regenerative. The set handles just like a good 7 Mc. superheterodyne.

W6DOB maintains a five meter schedule with G5BY 15.00 to 16.00 G.m.t. Saturdays and an hour later on Sundays. G5BY calls during the first and third quarter hours, listening in between. W6DOB is usually on about 56,020 kc. from 16.00 to 20.00 G.m.t. Sundays. G5BY is on 56,208 kc. W6IOJ is now on these same schedules on 56,100 kc. with a diamond antenna pointed at Europe with 100 watts T9X. W6DOB has 500 watts input.

Lloyd Jones says that more stations might call CQ on code on "five", requesting replies on 28 Mc. if they do not yet have satisfactory receivers for 5 meter c.w. reception.

W3GLV Report

We have received some very interesting notes from William Martin, Jr., who operates W3GLV at Leesburg, Va. He has been using a revamped 1-10 receiver used as a conventional regenerative T.R.F. receiver. We quote him below:

"I have been listening continuously since December 1, 1936. Have heard a great number of W5, W6, W7, and VE5 stations together with one PA0 and one K6 on 42 Mc., which is the third harmonic of 14 Mc. Also hear British Broadcasting Company television and voice carriers continuously from 9:30 a.m. until about 1:00 p.m., E.s.t. During the shortest skip period of the 27-day solar cycle these television signals from Alexandria Palace, London, come through with tremendous volume and little or no fade. The highest frequency used is only about 48 Mc., though. Have also heard German television on about 45 Mc.

"One thing interesting to me is the reception of all sorts of signals up to and including 49-50 Mc. (7th harmonic of 7 Mc.?). These come in more or less continuously regardless of the solar "dx" cycle. Only occasionally have these been identified, and so far all have been W6's.

"As to 56 Mc. dx, I heard K6MVV at 1:00 p.m., E.s.t. on February 24, also several unidentified phone carriers on 56 to 58 Mc. So far I have not heard any c.w. that I could positively identify except a 56 Mc. harmonic of a 14 Mc. station located 35 miles away that had me fooled for some time. The unidentified phone carriers were dx because they had the characteristic fade and waver of dx and were T9 carriers—a rarity among 56 Mc. fundamental transmitters. I also hear numerous local 56 Mc. signals 35 to 250 miles away which I can always distinguish by a pumping sort of fade peculiar to ground wave signals.

"W2XC, the television transmitter on the Empire State Building in New York, is on 53 Mc. for voice and 49.75 Mc. for the television carrier; when foreign and west coast stations hear this, it will probably be a good time for 56 Mc. dx. From observations, I believe that under average conditions the skip might be 500 miles on 14 Mc., 1000-1500 miles on 28 Mc., and 4500 miles on 56 Mc. The skip on the lower frequency bands will therefore probably have to be shorter in order to be favorable for two-way U.S.A. contacts."

The transmitter at W3GLV is on 56,004 kc. with 350 watts input on c.w. and 250 watts on phone, crystal controlled. Martin will be glad to arrange schedules on five meters with dx stations.

28 Megacycles

Some of the fellows point out that when the W stations fade out on ten meters in the evening, the band is not necessarily closed for the day. Listen later for J, ZL, and VK signals.

There is still lots of room for phones on 28 Mc. The other day we listened and decided that the whole 14 Mc. phone band could squeeze between any two adjacent 10 meter phones. This is particularly the case beyond about 28,500 kc., where the population falls off rapidly. Not that we necessarily favor phone operation, but it would help to relieve the 14 Mc. band of QRM if more stations could make use of 28 Mc.

There is an occasional complaint of code QRM on phone stations, and the reverse. We suggest dividing the 28 Mc. band—at least temporarily—in harmonic relation to 14 Mc. code and phone sub-bands, with no restrictions on the type of transmission from 28,500 to 30,000 kc. This would be the least disturbing to both W and dx stations, we believe, requiring no new crystals, etc. Any objections or suggestions from the gang? Don't forget to write to your A.R.R.L. director on this. It is almost sure to be brought up at the annual directors' meeting in May, and all ideas should be expressed by that time.

We enjoy the monthly reports of 28 Mc. conditions received from Nelly Corry, G2YL, because they give us some persepctive on conditions throughout the world. We quote her January report in full:

British Report

By Nelly Corry, G2YL

During the past two months there has been a slight, but perceptible, decline in the number and variety of signals heard on the band; but how much of this is due to a falling off of conditions, and how much to a decrease in activity, it is difficult to say.

In January, stations in Oceania, Asia, and South America were so scarce that a contact with one of these continents could be considered as something of an achievement. G6DH worked VK2GU and J2IN, and heard VS6AH and VU2AU, but did not log any South Americans, although the harmonic of HJO was heard almost daily. On January 4, VU2LJ reported that he and VU2AU had recently been neglecting the band, owing to poor conditions, but the latter was heard again towards the end of the month. The fact that J commercials are more consistent this year than last suggests that the lack of Asiatic signals is primarily a matter of inactivity. Of course it must be remembered that they do not get much encourage-

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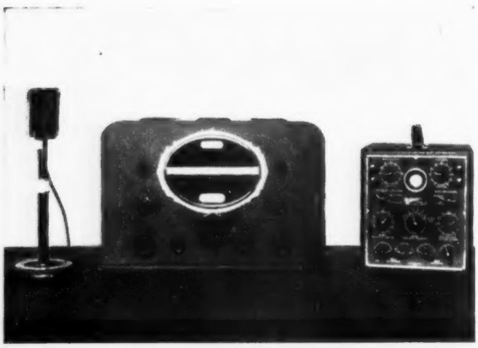
Amateur Radiophone W6ABF

By Philip Snyder, W6UT



Receiving position at W6ABF. A single stage of preamplification was built into the receiver, and the audio system of the receiver used to drive the grids of the modulators.

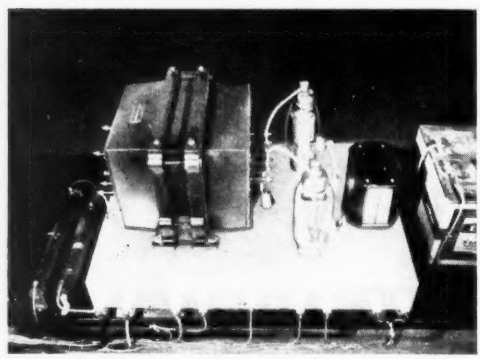
Offhand, it would seem that to describe an amateur as "the best known phone amateur in the umpth district" would evoke the wrath of dozens of amateurs who might dispute the title. That is why one sees references to "prominent" so-and-so district amateurs.

But in the sixth district it is a little different. No one would think of challenging the statement that W6ABF is, without doubt, the most well-known radiophone call in the sixth district. The friends Martin Brown has made over the air in the last few years are legion.

There are few amateurs using high power who could put in as many thousands of hours on the air as "Brownie" has without "stepping on a few toes". There are many high-power stations that the "210" gang are hesitant to call. But never W6ABF; he is as democratic as a grid-modulated 201-A. That explains his wide circle of friends.

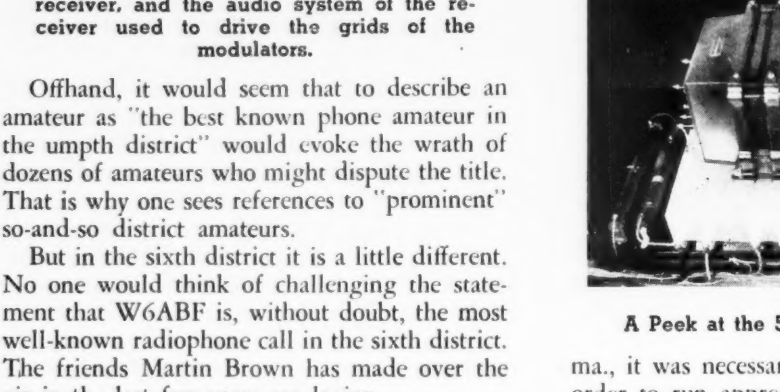
As Brownie himself occasionally tells the following joke on Martin Brown, it should be all right to repeat it here.

W6ABF had one of the loudest, most consistent, and best sounding rigs on the old 85 meter phone band. At that time a 50 watt phone carrier was "high power". Hence W6ABF stood out like a lighthouse in a fog. He modulated "several" 852's by a "flock" of 212-D's. Using class A audio and r.f. tubes rated at 85 ma., it was necessary to use several of each in order to run appreciable power.



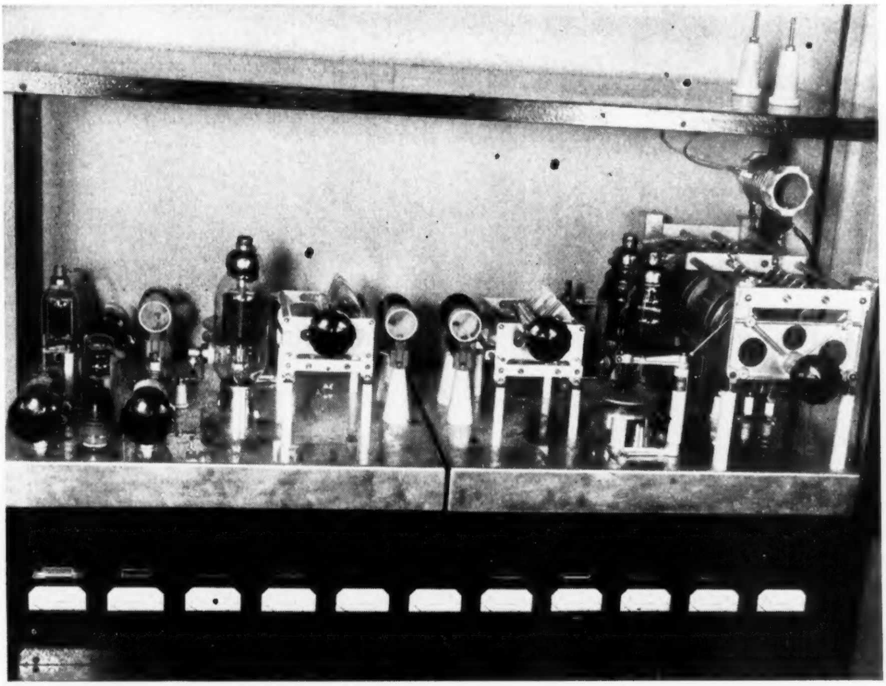
A Peek at the 500 Watt Modulator Unit

The transmitter represented his own work and was of his own design. It sounded much better than some of the broadcast stations on the air at that time. Other amateurs came to Brownie when they encountered trouble with their transmitters.



Then, one day, came into effect the unlimited license regulation. Brownie nonchallantly dusted off the questions in about 10 minutes and hurried away to keep an appointment—while the other amateurs were still laboring with the first question.

Evidently Brownie breezed through the questions a little *too* hurriedly. So we find our hero sitting



The r.f. section with front panel removed. Note the very neat and efficient mechanical construction for which Brownie is famous.

up on 160 meters with his 852's, all by his lonesome (160 was practically deserted at the time). There he was, with his high-powered, broadcast-quality phone transmitter and no one to keep him company. While on the 80 meter band were dozens of splattering, "mojalated wobbulators" whose owners hadn't been in such a big hurry when writing out the examination questions.

"The irony of it all was colossal," reflects Brownie. "I almost took up golf. You see *I* was the one who had been agitating for the previous six months for restriction of the phone bands and limited licenses."

However, he didn't have to stay up there long. As soon as the required waiting period was up he took the examination again, taking more time to answer the questions. This time he did so well that they frisked him on the way out to see if he had a license manual in his coat.

The present transmitter is used primarily on 10 and 20 meters at the time of this writing, though more operation will be done on 75 meters when 10 meters cool off a bit.

Starting with a "vari-gap" crystal unit, the rig uses a RADIO 6L6 exciter, capacity coupled to an HF-100 power doubler or buffer, capacity coupled to an HF-200 driver, which is inductively coupled to a pair of HF-300's in push-pull. As all the components have a large safety factor, nothing groans or grunts or gets hot with full 100% high-level modulation of 1 kilowatt input to the final stage.

Several antennas have been used in the last few months, and the antenna system is usually in the process of being experimented upon. Brownie's pet at the present time for 14 Mc. is a "J" fed full-wave horizontal radiator.

A crystal microphone and preamplifier kicks the speech system of the Breting receiver, which drives the HF-200 class B modulators through a 200 ohm line. His former transmitter used a pair of 204-A's in class B to modulate 852's in the r.f. section, but in line with current practice, he now uses "the little ones to kick the big ones", instead of vice versa. The HF-200 modulator, with its vari-match output transformer, is shown in one of the accompanying illustrations.

The entire transmitter is housed in a large steel rack. The front panel has been removed

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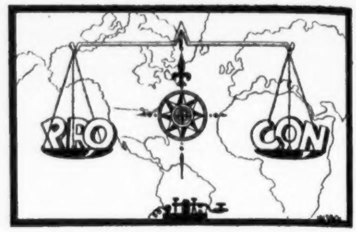
THE OPEN FORUM



CLASS "D" LICENSE?

Tulsa, Okla.

Sirs:

There are a good many fellows like myself who would like to get started in the amateur game—by "getting started", I mean starting in the *right way.*

I can receive "10 words per" now. With a little more practice I will be able to get the 13 or better. Some more studying and I will have the answers to the questions in the license manual down pat. I pass the exam, get my ticket and then, apparently, as some people seem to think, I know a transmitter from soup to nuts. But, that's a silly assumption. I know that, regardless of passing the exam, you've got to be on the air for some time before being able to make the transmitter perk right and stay that way.

Now, if it were possible for a fellow to get a license for five meters with the requirements the same as for class B *except the code exam!* Let the code requirement be about eight words per minute. Fix the length of time a person would have to stay on five meters—six months or a year—before he could apply for a class B. Then, make the class B exam a bit more strict than it now is.

This may sound bad to some of the beginners who want to work out-of-town stuff, but I don't think they should be allowed to bang around on the 40-meter band or bust the air open on 160 with 1000 watts just because they can rattle off at 13 per, "Mary had a little lamb", etc., and have a dear dad who furnishes the "rocks" to buy a new factory-built transmitter for all bands. The green newcomer operates it the best he knows how as long as he can get a CQ on the air (or maybe, not just one CQ but a solid half hour of them). When the rig goes haywire or quits, he has to get a real ham to fix it.

Anyway, I guess the boys on 40 meters are having a good time. I don't really know, because I can't keep one of them tuned in long enough to find out; the QRM from lids is too bad.

L. A. WILCOX.

NINETEENTH THE MOTION

Loraine, No. Dakota.

Sirs:

I have read with interest comments by our good friend Howard S. Pyle in the February "Open Forum". Mr. Pyle has very good reasons for complaining about the terrific "hog wash" c.w. interference, not only in the 40 meter band, but of late they are infesting the 20 meter band in a like manner. Something must be done and done quickly; at the rate the "lids" are taking over the bands it won't be long until they have all the old timers, and considerate amateurs, doing something very desperate.

While I have not been in the amateur game quite as long a time, or probably as consistently, I feel that I belong among the old timers, and those that have a little respect for others.

At the present time I do most of my operating on the 20 and 40 meter bands, working dx as my major ambition, and believe thousands will agree with me that even with a modern receiver it is absolutely impossible to have a decent QSO with our foreign friends due to terrific QRM from these "lids" and their meaningless blabber.

Judging by the sounds emanating from some of these outfits, the owners do not have any interest in how their signals sound—just how much interference they can create.

Self-excited rigs, improperly adjusted electron-coupled oscillators, yoops, gurgling sounds, raw a.c. notes, and even crystal-controlled signals covering 25 kilocycles, with key thumps and R9 key clicks all over the band are my pet peeves.

It is my personal opinion not all of these sounds come from class B or C amateurs; they come from *all* classes. What we need is more Government monitoring stations, a probation period of at least one year (in a small portion of the 160 and 80 meter bands for the newcomers), and no license to be issued to those under eighteen years of age. The age limit would prevent these countless numbers who come on for a year or so, and give it up as a bad job.

An amateur should be judged by the signal

he puts out and his ability as an operator, not by the class of license he holds. Strict requirements as to the type of apparatus that may be used should be set up, and before an amateur is allowed to leave the probation period he should be required to complete an extensive questionnaire, showing just what apparatus he has available, and how he intends to use it, with all details. In fact, what we need is district or state radio inspectors to make personal inspections (a costly job, but something must be done).

H. E. HOLMBERG, W9UBB.

WHAT IS A "WORTHWHILE" MESSAGE?

Brooklyn, N.Y.

Sirs:

In regard to W8DED's letter (February) concerning message handling, I have a few comments to make.

In his first paragraph he admits that message handling develops accuracy and speed, and then says, "Of what use is it to the good name of amateur radio and the public?" I suppose the accuracy and speed with which messages were handled to and from the recently stricken flood area were of no benefit to the name of amateur radio in the eyes of the public. Certainly this statement of his was a *faux pas* of the worst kind. As almost all of us know, accuracy and speed made the difference between the saving or losing of human life and property; and this is but one of many instances of a similar nature.

I would personally like W8DED's opinion as to a "worth-while message". I have handled hundreds of messages and have found almost every one of them perfectly reasonable, intelligent, and worth-while. But even if we admit that many messages are not worth transmitting because of their textual unimportance, does he consider what valuable practice these messages give one as to speed, accuracy and proper methods of procedure? Certainly we must have practice if we expect to cope with an emergency reliably and efficiently when one arises. These messages may seem immaterial and inconsequential at the time, but the practice gained by sending them proves of invaluable aid later on.

Maybe a good many messages are sent to boost up our monthly totals, but why not? In every field of endeavor we find competition; so why exclude it from traffic handling?

His remark concerning the QRM caused by traffic hams cannot be seriously made. How on earth can one call the clean, efficient, snappy operating of the traffic man *QRMing?* Certainly these punks with their endless CQ's, "bug dabblers", "V-fiends", and testers are the ones to blame for our interference problems. Most traffic men work break-in anyway, and keep schedules to get their traffic off promptly.

Traffic handling is real work, and there are few enough hams in the game now without discouraging newcomers.

Here is a phase of amateur radio which the general public understands, values, and appreciates.

GEORGE M. CLARK, JR., N2JBL.

WOOD PYLED ON THE FIRE

Philadelphia, Pa.

Sirs:

After reading Howard S. Pyle's letter, I've got a great deal to get off my chest.

First, let me say, at present I am an s.w.l. One of these days I hope to have a ticket. I am one of those guys who tunes over the band with a one-tube blooper with the regen. control all out.

I agree with H.S.P. that there should be some regulation of the c.w. bands. I myself believe that when I first start, I won't be fit to compete with *some* of these old timers who send 25 to 30 w.p.m. There is too much difference between 13 w.p.m. and 30 w.p.m. All you have to do to verify this is to tune over the bands once or twice.

H.S.P. wants 80, 40, and 20 meters closed to beginners and lids. I don't believe that 20 meters should be closed to them, as that is the principal dx band. You may say that they have 10 meters for dx, but that is too spotty for any consistent dx work. Why not close 80 and 40 to them and let them use 20 for dx?

Another thing, how long has it been since W7ASL worked Honolulu from Cincinnati on 160? I'll bet it's been quite a while. The 160 band is almost as bad for QRM as the 75-meter phone band. I can still remember when I first became interested in radio, when 100 watts was considered high power. Now a kw. is considered low power. You don't believe me? Well, listen in some time.

There is also the problem of greater b.c.l. interference to be had if the beginners and 13 w.p.m. men are relegated to 160 and the ultra-

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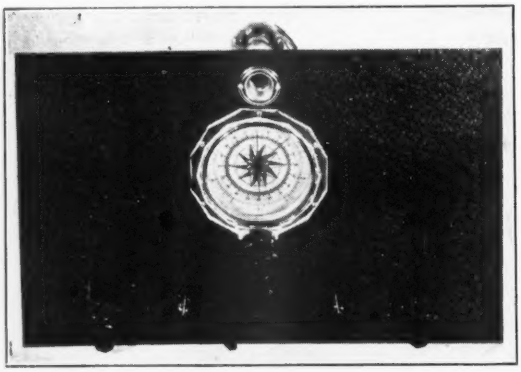
A Bandswitching, All-Purpose Superhet

By Raymond P. Adams*



A rather large number of magazine stories on receivers designed for or adaptable to communications service present either complicated or extremely simplified designs; and, as a result, whatever the informational worth of these articles to radio at large, they remain primarily of "constructional model" value to the advanced amateur, the beginner, and that uncertainly definable character, the so-called "experimenter". Few have described "in-between" jobs, or jobs using standard parts and suggesting more or less exact reproduction, and few have been expressly written for the many amateurs who, lately removed from the novice class, are casting about for moderately advanced designs to meet their general receiving requirements.

The receiver which the author takes this occasion to present should fill the breach pretty well. It uses standard parts throughout and suggests a basic circuit which will support such refinements as the builder may wish to add. It is thoroughly in step with present receiver engineering practice, yet suggests no greater complications of design and difficulties of construction. It is very definitely an all-wave job, and installed in a console cabinet, with its speaker properly baffled, there is no reason why it should not give exceptionally good service as a straight b.c.l. receiver. As a matter of fact, were it not for one or two features adapting it to amateur service, it might be simply called a rather efficient b.c.l. design which will not only dig down into the mud and bring in those elusive foreigners but can afford surprisingly faithful reproduction of local broadcasts.

Be that as it may it will operate very nicely as an amateur job and as an amateur job it is presented here. It has no crystal filter, and its minute-hand method of obtaining band spread may not appeal to some hams; but with its beat frequency oscillator, its noise suppressor circuit, its smoothness of tuning, and its high signal-to-noise and signal-to-image ratios it at least becomes an acceptable instrument for practical communications. One which not only may be built at reasonably low cost but which will, in the making, afford the builder an instructive experience in general all-wave design.

General Description

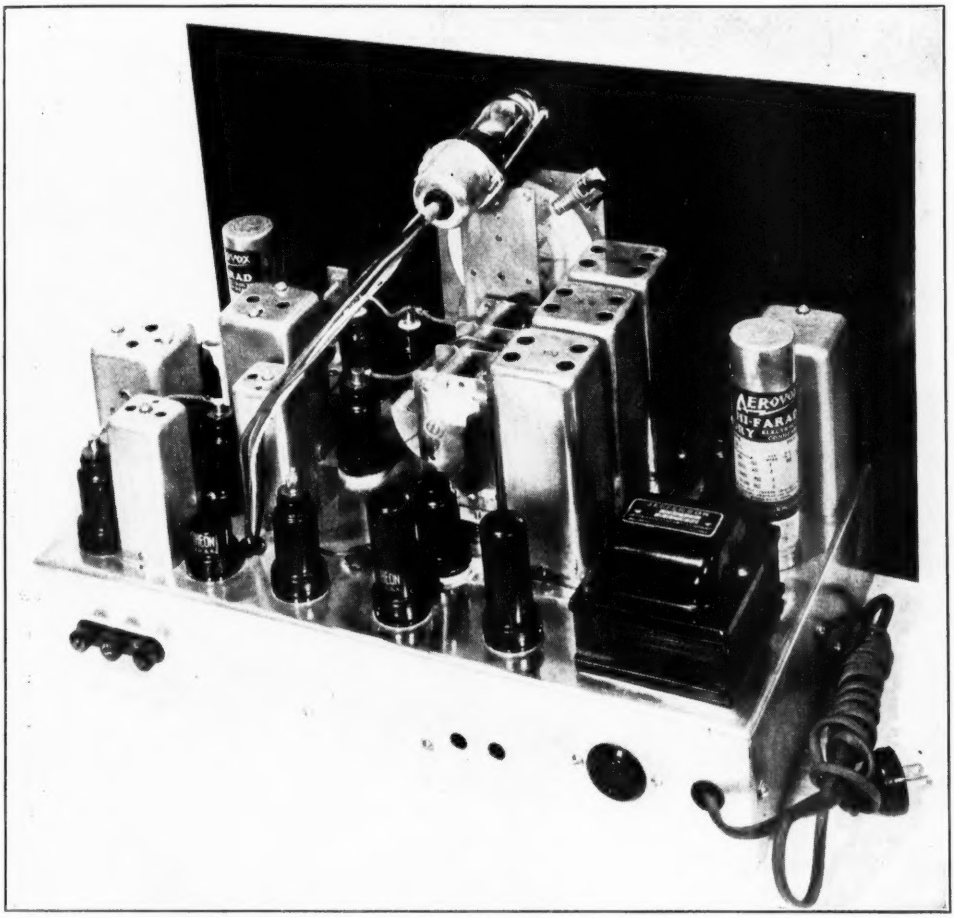
This receiver, which for want of a better name we will simply call the "All-Service Super", is a 12 tube affair with two parallel 6K7's in the r.f. stage, a 6L7 mixer, 6C5 high frequency and beat oscillators, a 6K7 and a 6L7 in two stages of i.f., a 6Q7 second detector-a.v.c. supply-audio amplifier, a 6G5 tuning eye, and a conventional two-tube Lamb noise suppressor.

Inexpensive but thoroughly proven and readily available parts are used throughout. The most important of these are, perhaps, the ready-built, three-circuit, four-band r.f. coil assembly and the i.f. transformers, two of which are of iron-core design and one of which has been particularly developed for noise circuit service. The power transformer is adequately rated—a husky job nicely shielded upstairs and down. By-pass and filter condensers have been carefully selected for accuracy and long service, and all resistors are of the insulated type.

There is nothing tricky or unusual about the circuit, except the use of the two tubes in the r.f. stage—of which more will be said later.

Bandspread is mechanical as previously noted. The dial is provided with the now-familiar second- or minute-hand pointer which records against its own 360 degree scale and moves much faster than the main pointer. The effect is a magnification of each degree of condenser travel by about 16 times, so that if an amateur band is confined to 10 degrees on the tuning scale it becomes extended to 160 degrees on the spreader scale. The drive is two-speed. This

*1717 No. Bronson Ave., Hollywood, Calif.



Looking Down upon the Chassis of the Bandswitching Superhet from the Rear

dual ratio combined with dual pointer system permits precise tuning and accurate logging.

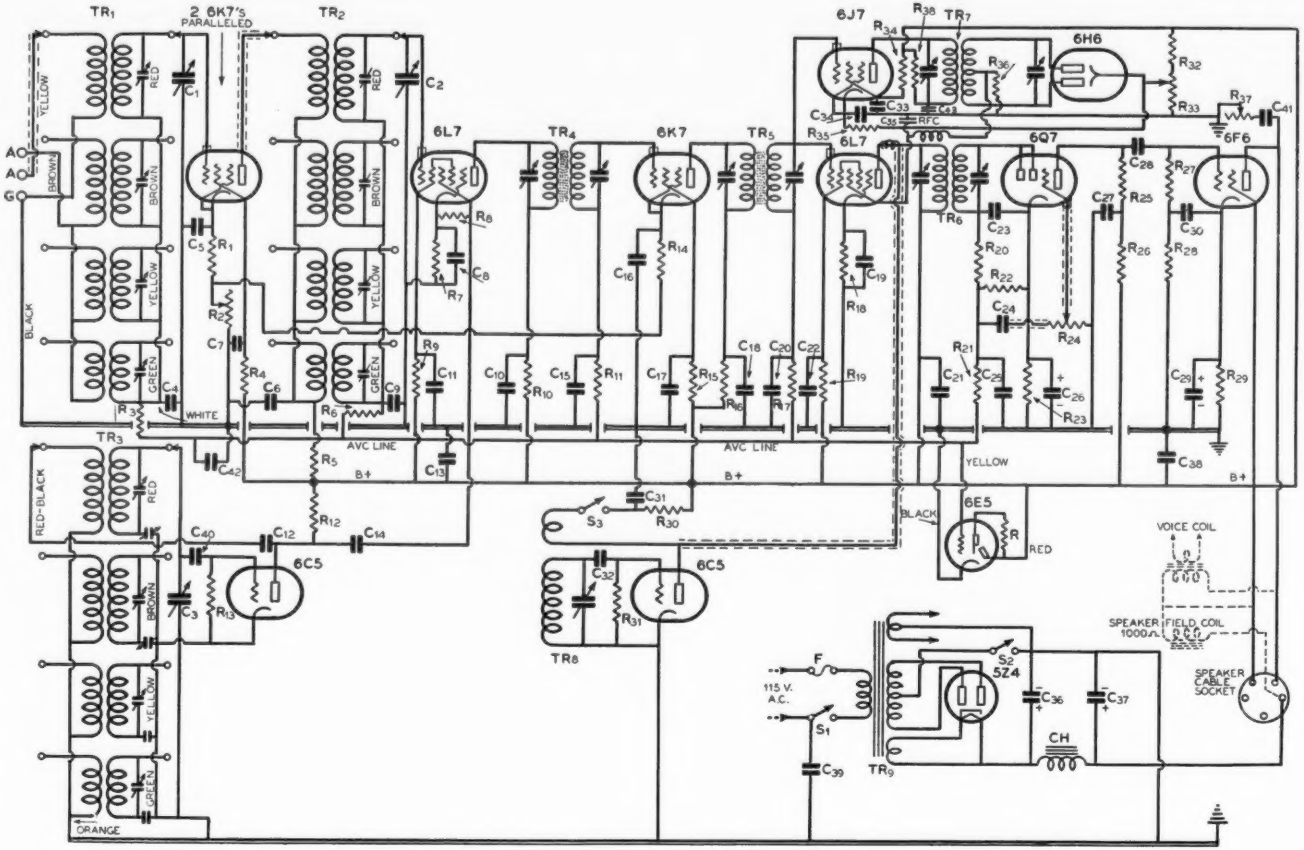
Layout

The layout has been arranged for the most efficient parts placement possible. Checking it over, we find the three-gang tuning condenser centered on the chassis and toward the front, with the high-frequency coil assembly on one and the r.f. and detector tubes on the other side of the tuning component.

It may be that some readers will object to the r.f. and detector tube placement with respect to the variable condenser, particularly because such placement makes long grid-cap to stator-lug connections necessary. However, we might just as well advise that no other set-up recommended itself at the time of construction. Compromise design is inevitable in an all-wave affair. The long grid leads in this particular instance were the penalty we were called upon to pay in return for short tank (*coil* to condenser stator) leads which our particular layout made possible and which we felt it by all means desirable to secure.

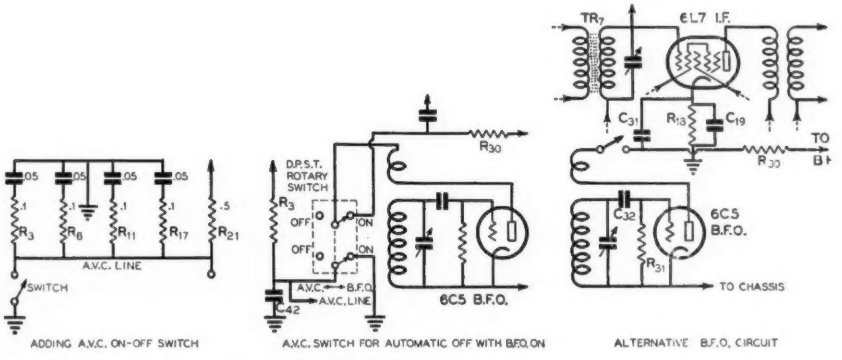
To the left (rear view) of the 6L7 mixer is the i.f. input transformer, and between this and the second of the larger i.f. coil components is the 6K7 first i.f. tube. The 6L7 second i.f. lies between the second transformer and the smaller output i.f. transformer shown behind and between the 6H6 noise rectifier and the 6Q7 second detector. The noise circuit parts are to the left, at the rear of the chassis, and so positioned that both efficient isolation and a short output connection to the 6L7 injector grid may be effected. The output pentode and the rectifier are lined up along the rear of the chassis to the right and toward the power transformer. Be-

C_1, C_2, C_3—3 gang .00036-.00042 μfd., low-minimum variable
C_4—.05 μfd., 200 volt tubular
C_5—0.1 μfd., 200 volt tubular
C_6—0.1 μfd., 400 volt tubular
C_7—0.1 μfd., 200 volt tubular
C_8—0.1 μfd., 200 volt tubular
C_9—.05 μfd., 200 volt tubular
C_{10}—0.1 μfd., 400 volt tubular
C_{11}—0.1 μfd., 200 volt tubular
C_{12}—.001 μfd. mica
C_{13}—.05 μfd., 400 volt tubular
C_{14}—.00005 μfd. mica
C_{15}—.05 μfd., 200 volt tubular
C_{16}—0.1 μfd., 200 volt tubular
C_{17}—0.1 μfd., 200 volt tubular
C_{18}—0.1 μfd., 400 volt tubular
C_{19}—0.1 μfd., 200 volt tubular
C_{20}—.05 μfd., 200 volt tubular
C_{21}—0.1 μfd., 400 volt tubular
C_{22}—0.1 μfd., 200 volt tubular
C_{23}—.00025 μfd. mica watt
C_{24}—.05 μfd., 200 volt tubular
C_{25}—.00025 μfd. mica
C_{26}—5 μfd., 25 volt electrolytic
C_{27}—0.1 μfd., 400 volt tubular
C_{28}—.05 μfd., 400 volt tubular
C_{29}—25 μfd., 25 volt electrolytic
C_{30}—0.1 μfd., 200 volt tubular
C_{31}—0.1 μfd., 400 volt tubular
C_{32}—.0001 μfd. mica
C_{33}—0.1 μfd., 200 volt tubular
C_{34}—0.1 μfd., 200 volt tubular



C_{35}—.00005 μfd. mica
C_{36}, C_{37}—8-8 μfd., 450 volt electrolytic
C_{38}—8 μfd., 450 volt electrolytic
C_{39}—0.1 μfd., 400 volt tubular
C_{40}—.0001 μfd. mica
C_{41}—.05 μfd., 400 volt tubular
C_{42}—.05 μfd., 200 volt tubular
C_{43}—0.1 μfd., 400 volt tubular

R—1 megohm resistor in eye unit
R_1—200 ohms, 1 watt
R_2—12,000 ohm potentiometer
R_3—100,000 ohms, ½ watt
R_4—50,000 ohms, 3 watts
R_5—2000 ohms, ½ watt
R_6—100,000 ohms, ½
R_7—600 ohms, 1 watt
R_8—50,000 ohms, ½ watt
R_9—25,000 ohms, 1 watt
R_{10}—2000 ohms, ½ watt
R_{11}—100,000 ohms, ½ watt
R_{12}—5000 ohms, ½
R_{13}—50,000 ohms, ½ watt
R_{14}—300 ohms, 1 watt
R_{15}—100,000 ohms, ½ watt
R_{16}—2000 ohms, ½ watt
R_{17}—100,000 ohms, ½ watt
R_{18}—2000 ohms, ½ watt
R_{19}—100,000 ohms, ½ watt
R_{20}—50,000 ohms, ½ watt
R_{21}, R_{22}—500,000 ohms, ½ watt
R_{23}—5000 ohms, ½ watt
R_{24}—500,000 ohm potentiometer
R_{25}—250,000 ohms, ½ watt
R_{26}—10,000 ohms, ½ watt
R_{27}—500,000 ohms, ½ watt
R_{28}—100,000 ohms, ½ watt
R_{29}—600 ohms, 3 watts
R_{30}—5000 ohms, 1 watt
R_{31}—500,000 ohms, ½ watt
R_{32}—50,000 ohms, 3 watts
R_{33}—5000 ohm potentiometer
R_{34}—100,000 ohms, ½ watt
R_{35}—400 ohms, 1 watt
R_{36}—100,000 ohms, ½ watt
R_{37}—12,000 ohm potentiometer
R_{38}—2000 ohms, ½ watt
TR_1, 2, 3—540-25,000 kc. coil assembly
TR_4, 5—456 kc. iron-core i.f.'s
TR_6—456 kc. air-core i.f.
TR_7—456 kc. noise transformer
TR_8—B.F.O. transformer
TR_9—Power transformer; 375 v. each side, 100 ma.; 5 v., 2 amp.; 6.3 v., 4 amp.
CH—20 hy., 100 ma. choke
RFC—16 mh. shielded r.f. choke



Three Optional Circuit Modifications

hind these, toward the panel, are an 8-8 dual electrolytic, the 6C5 b.f.o. tube, and the beat oscillator coil. One filter condenser (C_{38} in the circuit schematic) is near the panel at the opposite side of the chassis.

Front Panel

The top level of knobs, from left to right, are respectively, line switch and tone control, band switch, audio volume control, sensitivity control, and noise control. Beneath the line switch-tone control is the beat oscillator switch and below the noise circuit control is the communications switch.

Note that the audio level knob is set right below the dial, where it should be, and that the sensitivity knob, affording a manual means of varying the r.f. and i.f. bias, is not far away.

Under Chassis

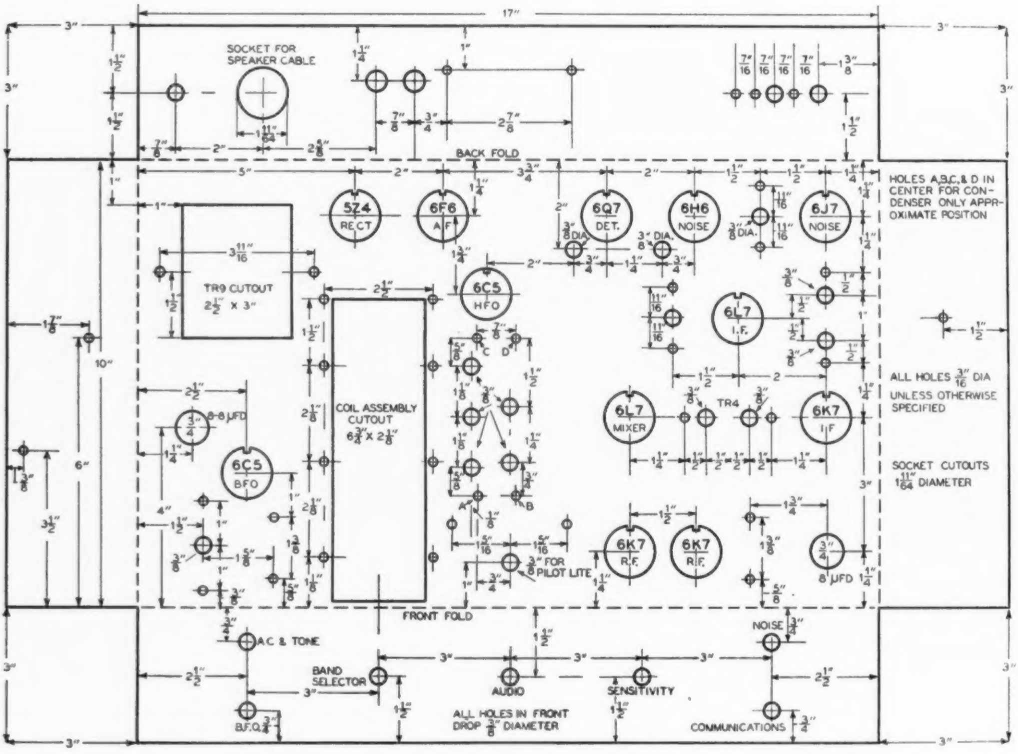
A glance at the under-chassis photo will bring several important points of parts placement and wiring to the reader's attention. First, the doublet leads from the antenna posts to the r.f. section of the coil switch, the plate lead from the paralleled r.f. tubes to the second switch section, and the audio volume control leads running across the width of the chassis are *all* run through shield tubing—not plain, ordinary shield braid, but true low-capacity tubing (the type ordinarily used in automobile antenna installations) which assures against any possibility of signal loss through high capacity to ground. Second, that the coupling lead from the beat oscillator to the second i.f. tube plate circuit is also shielded (here we are not greatly interested in signal loss, and low capacity tubing is not required). Third, that leads from the coil switch to the variable condenser stators go directly to the tuning capacity through grommets in the chassis. Fourth, that high frequency grid circuit returns are brought directly from the coil assembly through C_4 and C_9 to the chassis and that the points of chassis connection are selected where the variable condenser rotor leads are themselves grounded. Fifth, that all resistors and by-pass condensers are grouped around the sockets and are connected close to socket terminals or to tie-points fastened securely on the chassis. Sixth, that the sockets have been locked in such angular position as to permit the shortest possible leads to associated components. Seventh, that the bottom part of the power transformer is well shielded with a shell cover. Eighth, that the filter choke is mounted on the side wall where it will least interfere with humless receiver performance.

No attempt will be made to place all parts. Values of resistors and condensers are shown quite clearly. A careful study of both circuit schematic and photograph will permit exact identification.

The Circuit

The r.f. stage uses two 6K7's connected in parallel, with improved r.f. amplification and signal-to-noise ratio the very noticeable result. The effective plate resistance is halved and the effective transconductance is increased. Some readers may insist that capacity loading of the tuned circuits becomes increased with the paralleled tubes. Due to this, they say, such a system would work to decrease the signal. We won't argue with these folk. We'll simply say that we've tried the paralleled tube scheme and find it well worth the using.

The first detector is the conventional 6L7, its



Chassis Layout, Top View (Flaps Bend Down)

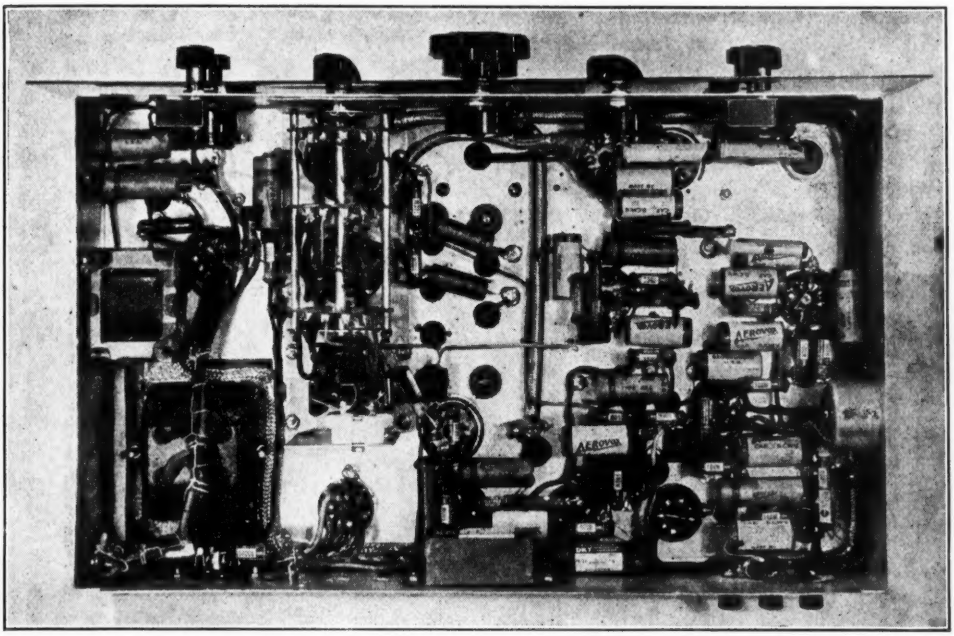
screen supplied with a higher-than-normal voltage (150), and its control grid (no. 1 grid) biased—6 volts. The high frequency oscillator is a 6C5 with its plate directly connected through a dropping resistor to the B plus supply and with its feedback coil d.c. isolated. The r.f. generated by the oscillator is fed to the no. 3 (injector) grid of the 6L7 through a coupling condenser. The return circuit for the injector is made to cathode through a 50,000 ohm resistor, R_8.

The first i.f. stage uses iron core input and output transformers for high gain and good selectivity. It is conventionally wired and is depended upon for the best part of the i.f. amplification obtained. The 6L7 second i.f. tube is biased rather high so that it will work properly in the noise suppression system. It is matched to the second detector by means of an air core transformer whose two windings have been pushed rather close together. The second i.f. stage, though it is primarily included in the set-up for noise suppression purposes, does, of course, give slight additional selectivity to the receiver in spite of the close windings in the output transformer and the loading effect upon this transformer of the diode section of the 6Q7 second detector.

It might be noted at this point that r.f. and i.f. circuit stability is assured by the use of decoupling resistors and by-pass condensers in all plate circuits and by individually feeding and by-passing all screens. It might further be noted that though the r.f. and first i.f. tubes are so connected that a variation of the potentiometer R_2 controls the bias voltage applied, each has its individual bias-limiting resistor and each cathode is by-passed to ground.

The 6Q7 does an effective job as second detector, a.v.c. rectifier, and first audio amplifier. The a.v.c. is fed to the i.f., r.f., and mixer circuits through the usual filter network (constants given in this writing for filter components may be relied upon to give a good compromise timing on both broadcast and c.w.). The a.f. is fed to the 6F6 output pentode, which gives all the power output required for dynamic speaker reproduction of the weakest of signals.

We won't go into details in connection with the noise suppression system. It is quite the conventional circuit and has been explained time and time again in the pages of various



Under-Chassis View of the Completed Receiver

radio magazines. Suffice to say that it works exceptionally well so long as the noise we desire to attenuate is above signal level in amplitude. It is important that the various components specified in the list of materials which relate to it be employed in its construction.

As for the beat oscillator, a word should be said with regard to it. The receiver as wired according to the diagram does not permit the switching off of the a.v.c., and the introduction of the beat frequency voltage does, to some extent, affect sensitivity. By keeping the strength of the beat low, however, and by working it into the plate circuit of the last i.f. tube, the effect, expressed as a loss in receiver sensitivity and an attenuation of weaker signals, is made negligible. Of course the builder may, if he so wishes, add a s.p.s.t. switch to short the a.v.c. line to ground when turned on, or substitute for the b.f.o. switch a double-pole double-throw one which automatically grounds the a.v.c. when the beat oscillator is made operative.

The tuning indicator mounting assembly used contains its own 1 meg. resistor. A 6G5 tube is suggested, as the 6E5 type will overlap badly on even moderately strong signals.

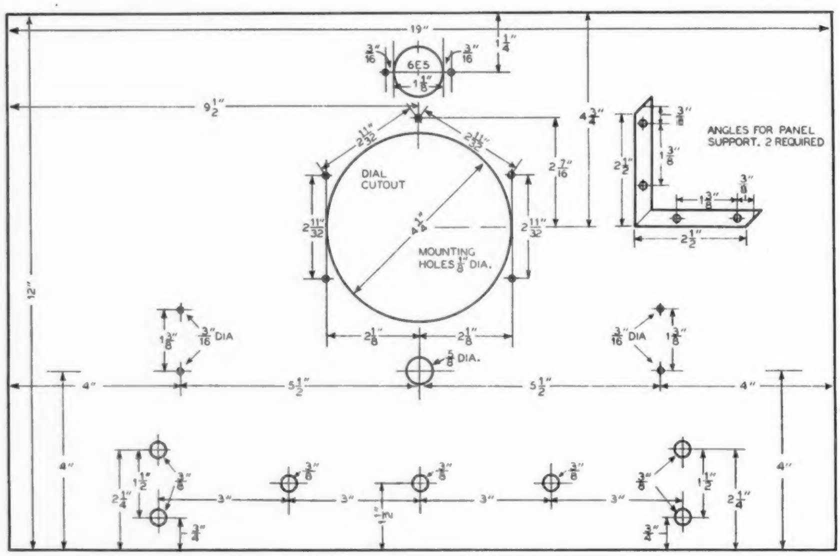
The power transformer has been designed for 100 ma. service, and the drop across CH and the recommended 1000 ohm speaker field is exactly enough at full receiver drain to provide a 250 volt output from the filter system.

Construction

No difficult r.f. coil construction will be required. The four-band coil assembly, pre-balanced and mounted on its own chassis for easy installation, is completely wired and contains all necessary trimmers and oscillator circuit padders. Its use simply calls for a special chassis cutout readily "stamped" in any chisel-and-hammer machine shop.

A word is in order at this point with regard to the variable condenser, which is simply mounted on the chassis with right angle brackets and elevated until it lines up with the dial hub.

This condenser may have a maximum capacity per gang of anything from .00036 μfd. (the conventional maximum) to .000420 μfd. If the .00036 size is employed, overlap on bands will not be had and some unimportant frequencies may be missed. Then, too, the broadcast band tuning may be such that stations on and below 570 kc. may be out of range entirely. Here it will be advisable to place external trimmers across the b.c.l. coils (*not* the variable tuning condenser sections, however), with the adjustments made so that both high and low limit stations may be received. The best practice will



Panel Layout. Material Is No. 16 Blank Steel Relay Rack Panel, Crackle Finished

be to shop around until a variable whose gangs have at least a 410 μμfd. maximum can be found.

Whatever the maximum capacity, that is, whatever the capacity of the unit at full mesh, the minimum C *must* be low—no greater, if possible, than 12 μμfd.

If the maximum capacity is from 360 to 400, it may be the best policy to use a dial with a plain 0-100 reading scale. If the capacity is in the neighborhood of 410 or 420, the builder may substitute a calibrated four-band scale such as the one which may be secured with the particular dial specified. Some slight inaccuracies in the alignment of the receiver to scale markings will probably be had at some points but the match will be satisfactory for rough approximations.

To get on with constructional details: The newer retainer-ring mounted sockets are used in the lab. model with steatites of high dielectric efficiency in the high frequency stages. If the builder plans to take our word for it that these ceramic affairs are far above the ordinary-run laminated jobs and to use them in his construction of an "All-Service Super", he might just as well know here and now that ordinary socket holes won't do *unless* the retainer-mounted sockets are secured complete with adapter plates. Otherwise they require a special die designed to stamp out a hole provided with a protruding lug for locking the socket into place. There are some of these dies available now. The job is to find one and prevail upon its lucky owner to do a little chassis work.

The panel may be mounted flush against the chassis front drop and secured by means of the various switch and potentiometer bushings or it may be extended away from the chassis and then fastened with five and ten cent store angle supports.

Wiring

Use low-loss r.f. wire (it should be available now through jobbing sources) in r.f. grid and plate circuits. Remember that we're using a switched-coil assembly and a standard high C tuning condenser, and that we must do everything possible to compensate for some losses which are unavoidable.

Wire in by-pass condensers and decoupling resistors close to socket terminals or mount them, as circumstances dictate, on tie points placed conveniently near components with which they are associated. Bring all ground returns to one point wherever possible for each circuit.

The color coding for the i.f. transformers con-

[*Continued on Page 45*]

The Question Box

By Jayenay

Why do all the modifications of the Reinartz crystal oscillator using the 6L6 which are currently appearing seem so critical and give such variable results?

All these regenerative oscillators obtain their regeneration from cathode impedances which, in some cases, place the whole amplifier above ground. Thus small changes in mechanical layout may cause a tremendous variation in amplitude and phase of the feedback. Thus in order to get high harmonic output it is necessary to play around with the oscillator in order to get things just right for stable oscillation with the crystal directing activities.

•

I have been told that it is illegal to test my transmitter on the air. Is this correct?

There are few tests of a transmitter which could not be conducted while working into a dummy antenna. It is perfectly permissible to conduct tests over the air with another station entering into the tests. Strictly speaking, most tests on the air constitute unnecessary interference as long as anyone else is using the band you are working on. Unnecessary interference is illegal, although the F.C.C. has not, to date, issued many citations to amateurs for unnecessary interference caused other amateurs. It is a good idea to limit tests to hours when the band is not in use. Thus, for 160, 80, and 5 meters, test from 4 to 6 a.m. and 9 to 12 a.m. weekdays only. On 40 meters there is no best time to test, but 9 to 12 in the morning on weekdays is about the best. On 20 and 10 meters perhaps from 1 to 5 a.m. weekdays would be best. Personally, I would like to see a definite F.C.C. ruling making on-the-air tests illegal except during the hours listed above.

•

What are the advantages and disadvantages of series plate modulation of a class C amplifier?

Advantages: Requires no modulation choke or reactive coupling device between the class A modulator and the class C modulated amplifier. Thus can handle ultra-high fidelity modulation and even high definition television signal modulation without appreciable frequency distortion.

Disadvantages: Difficult to adjust unless special, constant-current d.c. plate supply is used. Incapable of 100% linear and symmetrical modulation without special circuit tricks. Requires that the modulator operate in class A and be single ended, which is inefficient. (See Radio for January, 1936, for further data on series plate modulation.)

•

Explain a bit the terms "unloaded Z", (impedance), and "unloaded Q", in reference to amplifier plate tank circuits.

Z is the symbol for impedance. As most tank circuits are operated at resonance, we can neglect all reactance complexities and look at Z as a pure resistance which obeys ohms law. The term "unloaded Z" usually means the shunt resistance of the tuned tank circuit across which the radio frequency voltage is developed. This Z is the only load on the amplifier when the useful load is removed, and therefore determines what we call the "minimum d.c. plate current".

We always want the unloaded Z as high as we can get it, which means we want low tank circuit losses. We also want as high an unloaded Q as we can get. However, both these factors will be affected by the requirement that the *loaded* Q when the antenna is coupled up be not less than 5 or so, nor more than about 15. A low C tank gives high unloaded Z but low Q. A high C tank gives low unloaded Z and it also can give a value of loaded Q which may be higher than necessary. High unloaded Z allows high plate efficiency to be obtained. High loaded Q allows r.f. harmonics to be suppressed.

•

In a few words, what are the advantages of the "stabilized feedback amplifier" that is being mentioned so much lately?

Advantages: Cuts down harmonic and frequency distortion in audio and r.f. amplifiers. Cuts down hum and noise which originate in the amplifier itself. Allows cheaper amplifier components to be used for a given degree of fidelity. Cuts down harmonic distortion arising from speaker reactance and nonlinearity. Makes amplifier gain and power output relatively independent of changes in tube characteristics with age. Simplifies filter design for special purpose narrow-band amplifiers.

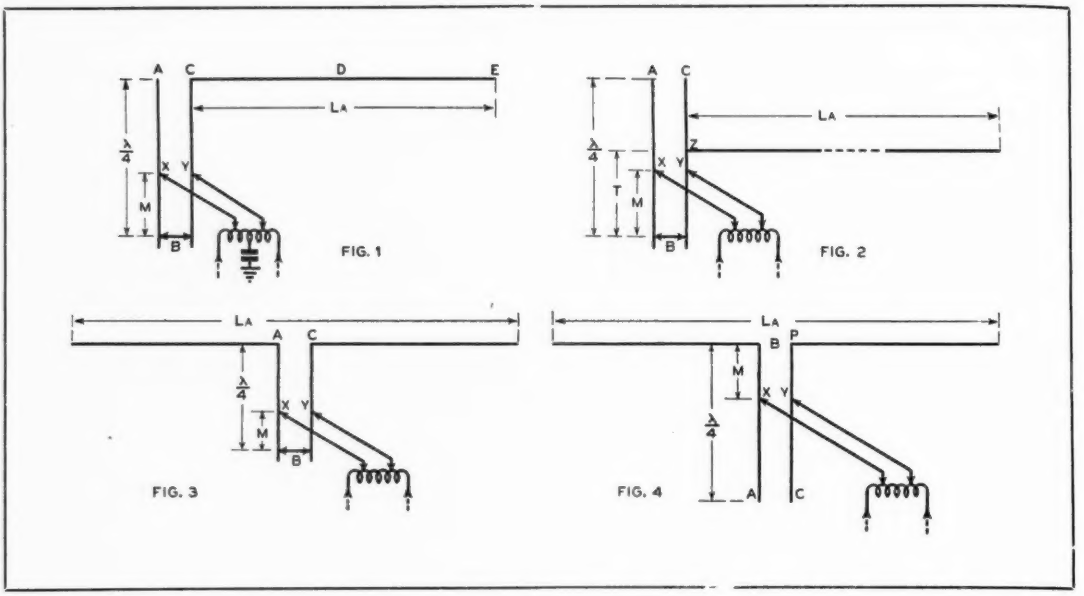
Disadvantages: Cuts down amplifier gain in exact accordance with the degree of improvement in performance. Usually necessitates from one to two additional stages of amplification for same overall gain. Requires careful design and construction if much benefit is to be realized. If not carefully designed will oscillate badly due to undesired phase shifts.

Comments: Stabilized feedback applied to just one stage is hardly worth the trouble, with the exception of the linear r.f. amplifier. The real benefits of stabilized feedback will come when it can be applied cheaply and simply to three or more cascaded audio amplifier stages.

•

Are filament bypass condensers really necessary? Some transmitter circuit diagrams show them and others do not.

Sometimes these bypass condensers are necessary and sometimes not. They most often are required with high voltage filament, high μ tubes when used on the higher frequencies in single-ended stages. Some amplifiers refuse to neutralize without these condensers. If the condensers do not improve the amplifier performance, leave them out.



The Matched Impedance "J" Antenna System

By J. N. A. Hawkins, W6AAR

The matched impedance "J" antenna system is not new, as it is simply a modification of the "zepp." antenna system. The "J" antenna system often has lower losses than the zepp. system. The main disadvantage of the J system is that it is a one-band affair, while most zepp. systems can be made to work on two or three bands well enough for most purposes.

However, one reason why the J system has not found wider use in amateur stations, although it is widely used in commercial and shipboard installations, is that there has not been a clear understanding of the tuning and adjustment procedure. Trying to tune up a J antenna system without this clear understanding of its operation almost invariably leads to trouble and bad standing waves on the transmission line where there should be no standing waves.

Another drawback to the J system is that all of its dimensions cannot be figured out on paper in advance and presented in the form of tables. Small differences in height, capacitance-to-ground, and other factors so markedly affect the apparent terminating resistance into which the transmission line "looks", that an experimental adjustment procedure is always necessary to effect proper antenna resonance as well as to terminate the line properly.

How It Works

In figure 1 is shown the simplest form of the J antenna system. Ordinarily the flat top length is an electrical half wavelength and the matching stub has an electrical length of a quarter wavelength. If it were not for the shorting bar at point B and the presence of the transmission line tapped on the stub, the system would look exactly like a simple form of zepp. or folded full-wave antenna, which is just what it is (in disguise). The folded portion of the antenna, from A around to C, constitutes the impedance matching stub whose function is to act as an impedance transformer. Thus the stub transforms the useful antenna resistance at point C into another value of resistance at points X and Y, which new value of antenna radiation resistance represents exactly the right terminating resistance for the untuned transmission line which carries radio frequency energy from the transmitter to the antenna. It is necessary and desirable that the untuned line from the transmitter work into just the right value of reflected radiation resistance, regardless of the power or

the frequency, in order to minimize undesirable radiation and losses in the line itself.

The impedance-matching stub ABC has each leg a quarter wave long. Thus the total length of the two legs equals a half wavelength. As this type of stub is used only with radiators whose length is an even multiple of a quarter wavelength, (half wavelength, full wavelength, three halves, etc.) there will always be high voltage at both ends of the radiator. Thus points E and C are points of high r.f. voltage, while point D is a point of low r.f. voltage. We are not concerned with points D and E, but if point C is a point of high r.f. voltage, then point A must also be a point of high r.f. voltage, as the distance from C to B and from B to A equals two quarter wavelengths, or a half wavelength. Thus it should be obvious that the stub is simply a half wave antenna folded up to save space and to minimize undesired radiation from this portion of the antenna system. Except for the fact that the stub does practically no radiating of r.f. energy, it acts just like a half wave antenna, or any other type of tuned circuit operating at resonance. Therefore it has high r.f. voltage at its ends, points A and C, and low r.f. voltage at its center, which is point B.

As the power in any tuned circuit, or simple antenna system, is always the same throughout the system, a difference in voltage in various parts of the system must be offset by an equal and opposite change in current. Thus at the high voltage points low current is found, while at the low voltage points high current is present. The product of voltage times current at any point in the system must be equal to the product of voltage and current at every other point in the system, if the power is the same throughout the system. This is true by the definition of power.

The system can be fed r.f. energy at almost any point in the system. If it is fed at or near points A or C, the power will have to consist of high r.f. voltage at low current. If fed at point B the same power would have to be delivered to the system in the form of low r.f. voltage and high current.

Thus, while the same power could be fed to the system at any point between B and A (or C), that power would be fed into a load of variable characteristics. The only change that occurs is that the reflected radiation resistance of the system varies from a low value at B to a high value at A and C. At intermediate points between B and C (or A) we can get any intermediate value of reflected radiation resistance we want merely by suitably choosing the distance M from point B to the point where our source of power is tapped on the line.

The stub ABC automatically steps up the voltage of the power source so that it delivers just the right proportion of volts and amperes at point C where the matching stub connects onto the radiating portion of the antenna. This is just another way of saying that the impedance, or resistance, transforming action of the stub has changed the antenna resistance, as measured at point C, into just the right value of reflected, or transformed, resistance to match our source of power, which is attached to the stub at points X and Y.

In figure 1 our source of r.f. power happens to be the untuned transmission line from the transmitter itself, although the untuned line could have been eliminated and the transmitter terminals tapped directly onto the stub at points X and Y had it been convenient and practical to do so.

This impedance, or resistance, transforming action of the quarter-wave stub ABC is very similar to the action of the Q bars in the Q antenna system.

This feeder system has very low losses when properly built and adjusted, mainly due to the fact that the stub section is usually up in the air and away from conducting objects which otherwise would absorb a large amount of power from it. This power absorption from a *resonant* line is the main objection to the zepp. antenna system with feeders more than a quarter wave long.

Tuning the Feeder System

The adjustment of the J feeder system is not difficult provided the three important steps are taken in the proper order and each step is completed before starting on the next one.

The three steps are:

1. *Establishing resonance in the radiator and matching stub.* The only adjustment involved here is the position of the shorting bar "B" on the stub.
2. *Properly terminating the untuned line on the stub.* The only adjustment involved here is sliding the taps "X" and "Y" up or down the stub until standing waves disappear from the untuned line.
3. *Obtaining optimum coupling between the transmitter and untuned line.* This is a matter of finding the proper point at which to tap the untuned line on to the plate tank of the final amplifier.

This system *must* be adjusted in the order given above, and whenever it is found necessary to readjust the first or intermediate steps, the following steps will also have to be readjusted in their turn.

While this adjustment procedure will discuss the simple J matched system shown in figure 1, this procedure is generally applicable to the adjustment of all matched impedance antenna systems using a closed stub as the impedance transformer. The adjustment of the open stub matching systems is quite similar but differs slightly in detail. These other stub match systems will be taken up later.

Establishing Resonance

The length of the radiating portion of the antenna is taken from any of the accepted antenna length formulas. For a half-wave radiator divide 468 by the frequency in *megacycles* to get the length in feet. The length of each side of the matching stub (electrically a quarter wavelength) is obtained by dividing 240 by the frequency in *megacycles*, the answer being in feet.

It is a good idea to cut the antenna to exact length as closely as possible. The two sides of the matching section may be cut about 3% too long to provide room for adjustment. Now to tune the antenna and stub system to resonance. There are several different ways to excite the antenna during this preliminary adjustment. The best method is to use an end-fed wire coupled to the transmitter and running approximately parallel to the radiating portion of the J antenna and about ten feet away. The temporary exciting antenna is used only during the resonating adjustment and can be as haywire as you like, just so some energy is transferred to the system undergoing adjustment. If a separate exciting antenna cannot be rigged up it is permissible to use a single-wire feeder connected onto the J antenna about two-thirds of the way between points E and D. This single-wire feeder should be loosely coupled to the transmitter and the final amplifier plate voltage should be reduced to a safe value to avoid the possibility of overloading the final amplifier during adjustment. Note: a good high voltage series blocking condenser must be used in this single-wire feeder to keep direct plate voltage off the antenna.

Lower the antenna until the bottom, or point B in the stub, can be reached for adjustment. Then turn on the transmitter on low power and increase coupling to the temporary single-wire feeder until a convenient reading is obtained in a radio frequency ammeter, milliammeter or galvanometer shunted across part or all of the shorting bar B. With very low-power transmitters or high-range r.f. ammeters it may be necessary to connect the meter in series with the shorting bar, but usually this will not be necessary, as quite low power can make rather high current flow in the shorting bar.

Now the position of the shorting bar should be changed in small steps up and down the stub until a maximum current reading is obtained through the shorting bar. This point will be fairly critical. One inch at 20 meters will make quite a difference in the current. Be careful of two things at this point. Be sure the transmitter is always turned off before moving the shorting bar and be careful not to burn out the r.f. indicating meter as resonance is approached. When the point of maximum current has been established, cut off all but an inch or so of the excess stub length and make a slight readjustment of the shorting bar for maximum current. The excess wire cut off below the shorting bar will slightly affect the point of maximum current. Then when this second adjustment has been completed, cut off any remaining excess stub below the bar and solder the shorting bar across the stub. Due to the high current flowing at this point it is very important to do an especially good job of this soldering operation. Wrap the wire of the shorting bar around each of the sides of the stub several times, and use plenty of resin-core solder and a good hot iron.

Terminating the Untuned Line

The temporary single-wire feeder or the "haywire" end-fed exciting antenna can now be removed and the two-wire untuned line loosely coupled to the transmitter. The antenna end of the line should be equipped with a pair of husky copper spring clips, or clamps, to enable the line to be attached at various points up the stub. Start in by tapping the two-wire untuned line about a third of the way up the stub from point B in figure 1. This would make distance M about a twelfth of a wavelength. This position need only be located approximately. Next turn on the transmitter and tune the plate tank to resonance to keep the tubes in the final amplifier cool. Low power should be used at this point.

Now check the current or voltage along the transmission line. This can be done in a number of ways. The best method is to have three points along the line, a sixth wave apart, and successively put a low-range r.f. ammeter in series with the line at each of the three points.

The currents at all three points will be exactly the same when the line is tapped on the stub at the proper point. Some readjustment of the transmitter output may be necessary to get sufficient current in the line to give a convenient reading on the meter. A little thought will show that *usually* two points located a quarter wave apart in the line are enough to show the presence or absence of standing waves on the line. However, sometimes a current loop or current node happens to fall exactly half way between the meters, at which time they would read equal currents in spite of bad standing waves on the line. Under no conditions could equal current appear at three points separated by a sixth of a wavelength unless the standing waves were all gone. The sixth of a wavelength separating the three meter reading points need not be exact. As a matter of fact, the distance between the meter reading points could be anything convenient just so that it is somewhat more than an eighth wave and not exactly a half wave or multiples of a quarter wave.

R.F. Meters

One meter will do as well as three meters for checking the presence of standing waves on the line. In fact, one meter will be even better than three meters because it is rare to find three r.f. meters costing under fifteen dollars each that will read alike to 10%. It is obvious that if the three meters do not read alike it will be difficult to determine whether standing waves are present or not. Some amateurs have solved this problem by adding an extra section of untuned line at some convenient point in the line just to get a convenient means of reading the line current at three points. Note that the length of the untuned line has nothing to do with the operation of this antenna system. It will not detune the system or necessitate any changes in adjustment. An extra section of line can be cut in or out without any effect except to affect slightly the very low inherent line losses.

Move the line taps up or down the stub until the standing waves are brought to a minimum as evidenced by approximately equal current at separated points along the untuned line. Pay no attention to the actual value of the current in the untuned line; what you want is equal current along the line.

This current could be read in a number of ways. Some amateurs have made two small clips out of strip brass to attach to the terminals on the r.f. meter. These clips have hooks at their upper ends so that the meter can be hung over the line and then slid along by means of a stick. The main trouble with this method of reading line current is that the clips usually make a poor and variable contact with the line, and also it is difficult to make clips which always attach the meter across equal lengths of line. Other systems have used trolleys or meters supported by pulleys from the line but they all represent difficult mechanical problems in order to get consistent readings.

Another method which requires no meters at all gives fairly good results, but the line length must be close to an odd multiple of an eighth wavelength.

When a transmission line is an odd number of eighth wavelengths long it reflects reactance back into the transmitter feeding it, unless the line is properly terminated and there are no standing waves on it.

Thus such a transmission line would tend to change the *tuning* of the plate tank condenser for minimum d.c. plate current except when the standing waves are absent from the line.

Such an arrangement would be adjusted as follows: See that the line is not an even multiple of one-eighth wavelength long, and for best results, its length should be fairly close to an odd multiple of one-eighth wavelength.

Tune the plate tank condenser of the final amplifier of the transmitter to resonance with the transmission line disconnected from the plate tank coil. Log the condenser setting of this resonant point. Then turn off the transmitter plate voltage and tap the transmission line on the plate tank coil each side of center and apply low plate voltage to the transmitter. Retune the final plate tank condenser for minimum d.c. plate current. If minimum d.c. plate current appears at a different condenser setting than it did without the line being connected to the final tank, then standing waves are present on the line and the point where the line taps on the matching stub will have to be changed. Note that there is *nothing* that can be done at the *transmitter* end of the line which will either increase or decrease the standing waves on the line. No trick antenna coupling networks have any effect and this type of line should be adjusted with such networks out of the circuit.

Because the line should be tapped on the plate tank, series blocking condensers should

[*Continued on Page 74*]

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A. E. Lower, XU3XA-XU9XA, and C. Martineau, XU3CM, XU8CM, KA1CM, Chinwangtao, N. China (Near Peiping)
(Sept., 1936.)
(14 Mc.)

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(November, 1936.)
(14 Mc. phone)

CE3AC; CE3DW; CO2AF; CO2HY; CO2KY; CO2LL; CO6OM; CO7CX; CO8YB; CP1GB; CT1DV; CX1AA; CX2AK; F3GR; F3JD; F8DR; F8II; F8OO; F8UF; F8UP; — G 2IB; 2MV; 2XV; 2YZ; 5BJ; 5JO; 5JZ; 5ML; 5NI; 5PW; 5RV; 5VL; 5WH; 5WP; XG; 6AG; 6AH; 6CW; 6DH; 6DL; 6DT; 6FS; 6KG; 6LK; 6LL; 6XR; 8AR. — HH2B; HH2B; HI2K; HK1GK; HK1Z; I1KS; J2KB; J2KJ; — K 6FAB; 6FJB; 6FKN; 6GNW; 6INF; 6JLV; 6KKP; 6KPF; 6MTE; 6NTV. — KA1BH; KA1ER; KA1ME; LA1G. — LU 1BJ; 1EX; 4BA; 4BH; 5BY; 5JA; 6AP; 6KE; 7AZ; 7ET; 8AB; 8DR; 9PA; — OM2BC; NY2AE; OA4AA; OA4AB; OA4AI; OA4AK; OA4AP; OA4R; ON4MG; ON4PA; ON4VA; ON4VK; ON4ZA; PK1GW; PK1JR; PK1MX; PK1ZZ; PK3ST; PK4AU; PY2AK; PY2BA; PY2CK; SM5SX; SU1CH; SU1KG; TI1AF; TI2AV; — VE 1CR; 1DQ; 1IN; 2HF; 3DB; 3HC; 3JV; 3PM; 3WZ; 4CM; 4CS; 4FD; 4GL; 4KW; 5BY; 5HA; 5KY. — VK2ABD; VK2ABG; VK2ACO; VK2ADA; VK5AW; VK6MW; VO1I; VP2CD; VP4TH; VP6YH; VS4CS; VS6AF; VU2BG; VU2DY; VU2HQ; VU2LM; XE1AI; XE1CS; XE1LC; XE2AH; XE2HF; XE2N; YN1OP.

I1ER, Italy
(Oct. 18 to Nov. 22, 1936.)

W 1ALB; 1AXA; 1HDQ; 1KH; 1TW; 2AOG; 2BCR; 2CTA; 2DTH; 2FK; 2ZA; 3COD; 3DBX; 3EBP; 3FS; 3GHS; 5BDB; 8BTK; 8CRA; 8CKY; 8EBS; 8IFD; 8JAK; 8MWL; 9ADN; 9LQU. — SU1SG; VE2CA; VE3TY; ZS1H.

J. Vincent McMinn, NZ16W, 12 Edge Hill, Wellington C-3, New Zealand
(November - December, 1936.)
(7 Mc. phone)

LU8BR-7.

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(14 Mc. phone)

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(14 Mc.)

CE2AR-5; CM2GE-6; CM7AI-5; CT1BT-6; CT1BY-5; CT1DT-5; CT1KH-6; CT1KR-5; CR9AA-5; CR9AB-6; CX1BO-6; — D 3DLC-6; 3GKR-4; 4BMH-6; 4BUF-5; 4CXG-6; 4GJC-6; 4OFT-6; 4QET-6; 4SDA-5; 4SNP-6; 4UYD-6; 4VRR-6; 4YBF-5; EI8G-5; EI9G-6. — F 3AK-7; 3DN-5; 3GS-6; 3IC-6; 3KH-5; 8CP-6; 8DC-6; 8EX-6; 8FC-7; 8FK-5; 8GV-5; 8IG-5; 8JD-6; 8LK-5; 8MG-6; 8NR-6; 8RR-5; 8SN-5; 8UK-5; 8YG-6; 8ZF-6. — FA8DA-6; FA8GK-6; FB8AD-6; FT4AA-6; FT4AC-6; FT4AE-5;— G 2PU-5; 2ZP-5; 2ZY-5; 5JO-5; 5MS-5; 5RI-5; 5VB-4; 5YH-5; 6CW-5; 6KP-5; 6NB-5; 6NJ-5; 6WA-5; 6YN-5; 8CT-5; 8FZ-4. — GI6TK-5; HAF5C-6; HAF8D-6; HAF8G-6; HB9AK-6; HB9AY-7; HB9BD-6; HM9J-7; HB9Y-6; HC2MO-5; HH5FG-7; HS1PU-8; I1IR-6; I1IT-5; I1KN-5; I1TKM-6; G8CF-5; K5AA-6; K5AI-6; K5AM-6; LA2Q-5; LA2X-6; MX2AN-7; OE3FL-7; OE3KH-6; OH2OG-6; OH3NP-6; OH3OI-6; OK1PK-6; OK1WF-6; OK1ZB-5; OK2HK-5; OK2KO-6; OK2KP-6; OK2LO-6; OK3MS-6; ON4BR-5; ON4FE-5; ON4GW-5; ON4JO-7; ON4PA-5; OZ1I-5; OZ2B-5; OZ2B-5; OZ3J-5; OZ8A-4. PAO AZ-5; FP-5; IW-5; JV-7; MG-5; MQ-5; QZ-5; SD-6; XM-7; ZB-4. — PK1MO-6; PK2HD-6; PY1FZ-6; PY2AC-6; PY2AE-6; PY3BP-7; PY4AP-6; PY5BO; SM7UC-7; SU1AP-7; SU1CH-7; SU1FS-5; SU1KG-5; SU1SG-6; SU1WM-6; SV1KE; TI2LR-6; U3GE-7; VQ8AF-6; VQ8AH-5; VE1EA-6; VE2ER-6; VP2GA-5; VU2BA-7; VU2BY-6; VU2GB-6; VU2LS-5; VS1AL-6; VS7MB-5; VS7RF-5; VS8AAP6; VO1X-6; XE1DA-6; XE1DD-6; XU3FK-5; XU8HW-5; ZB1H-5; ZE1IF-5; ZE1JS-4; ZS4J-5.

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*George Walker, Assistant Editor of RADIO, Box 355, Winston-Salem, N.C., U.S.A.

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W. C. Clark, W4BJX, 1420 Boulevard N. E., Atlanta, Ga.
(November, 1936)
(14 Mc.)

CN8AC; CN8AP; CR7MB; CR8BB; CR9AD; 412A; FB8AB; FB8AF; FB8AG; FY8C; J 2CC; 2CL; 2HQ; 2IS; 2JJ; 2JK; 2JN; 2KJ; 2LB; 2LK; 2LL; 2ME; 3CR; 3CX; 3DP; 3FI; 3FJ; 5CC; 5CE; 8CD. — KA1AN; KA1AP; KA1US; PK1ML; PK1MO; PK4XD; PZ1AL; TF5C; U9AB; U9AC; U9AL; U9AY; U9MH; VQ3FAR VQ4CRA; VQ4CRE; VQ8AA; VQ8AB; VQ8AF; VQ8AP; VS6AB; VS6AH; VS7AJ; VA8AA; VU2CB; VU2CD; VU2CQ; VU2FD; VU2FY; XU3LA; XU8LR; XU8ND; XU8OP; XU8RO; ZC6CC; ZC6CN; ZE1JJ; ZE1JS; ZS1AN; ZS1H; ZS2X; ZS5C; ZS6AF; ZS6AJ; ZS6AP; ZS6AY; ZT5M; ZT5R; ZT6AL; ZT6AU; ZT6N; ZT6Y; ZT6Z; ZU1T; ZU6E; ZU61; ZU6M.

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(December, 1936)
(7 Mc.)

CM6RC; D4FZI; D4XCG; F3IC; F8XE; F8YH; G2PL; K6CGK; K6OGO; PA9UN; SM6SO; TI3FZ; ZL1FF; ZL2CP.

(14 Mc.)

CM2AO; CM6OW; HI2T; HK3IA; IZT6Y; K6MXN; LU3HK; PK1MO; PY1AZ; PY1BB; PY1BR; PY1DC; PY1DH; PY2BX; PY8AH; ZL4BQ; ZS1AV.

(28 Mc.)

CM8AI; CP1AC; CT1KH; D4AUU; D4BUF; D4DLX; D4FND: D4MDN; D4NCK; D4XQF; F3KH; F8QL; F8RR; F8WQ; FA8LH; FB8DB; G2OA; G2PL; G2XC; G5BM; G5FV; G5JA; G5IS; G5KH; G5VX; G6AY; G6CW; G7DH; G6GR; G6LK; G6NZ; G6QZ; G6WN; G6YL; HAF8D; HB9BG; LA6A; OE1ER; OE1FH; OH5OD; OK2OP; OK2RS; OZ7G; PA9AZ; PA9ZK; SU1SG; TI2EA; VK2GU; YM4AA; YR5AR; YU7DX; ZE1JR; ZS1H.

Alois Weirauch, OKIAW, Mestec Kralove, Czechoslovakia.
(Oct. 1 to 31, 1936)
(28 Mc. phone.)

W 1ADR; 1CCZ; 1CHG; 2ENX; 2FWK; 3CYK; 9IJZ.

(28 Mc.)

W 1CEZ; 1CFD; 1COI; 1FH; 1HIO; 1OIB; 2DTB; 3CKD; 3CYF; 3EVT; 4AUU; 5AFX; 5BEE; 5FY; 6FAY; 6GLI; 6GRX; 7AMX; 8CRA; 8GFD; 8IFD; 8IJZ; 8IWG; 8NK; 8OKC; 8PT; 9ANA; 9BYE; 9DTB; 9DZX; 9ICW; 9JFB; 9UYD; CN8MI; CN8MQ; CT1CO; FA8CR; FB8AB; FT4OG; G2LK; G2OA; G5JU; G5QY; G6CW; G6GN; PY2BR; SU1RO; VE1AM; VE2AC; VE3ADM; VE3DU; VE3ER; VU2AU; ZS1H; ZT6Y; ZU1C; ZU6C.

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(Oct. to Dec., 1936)
(14 Mc. phone)

W 3EOZ; 4AKA; 6CWH; 7EPS; 9GIC; 9PWV; CE3AA; CE3DW; COVCX; CO8YB; F8VP; HI7G; HK1Z; HK3HS; HK3JA; J3EM; J3FK; KA1DL; KA1ER; KA1KY; KA7EF; KZYY; LU6KE; LU7ET; LU9PA; OA4AB; OA4AI; OA4R; ON4VK; ON4ZA; PK1PK; PK1QU; PK1VH; PK1ZZ; PK3AA; PK3GD; PK3WI; PK4AU; SU1CH; SU1KG; TI2RC; VE1CR; VP6YB; VS1AB; VS1AK; VS4RC; VS6AB; VU2AG; VU2BG; VU2BY; VU2DY; VU2HQ; VU2JN; VU7FY; XE1G; XU6SW; XU9HW; ZE1JR; ZS6Q.

Paul T. Norman, W8PCU, 40 Palisade Pk. Rochester, N. Y.
(Jan. 16, 1937)
(28 Mc. phone)

CT1KH-8; D3AAN-7; D3LSR-7; D4DLC-7; D4KPJ-7; F8MG-5; G2HX-7; G2QB-7; G6IR-8; G6WY-6; G6VX-7; K4EJF-7.

E. H. Swain, G2HG, 31 Woodbastwick Road, Sydenham, London, S.E. 26
(February, 1937)
(28 Mc. code)

LU9BV; SU1KG; SU1RO; VE1DE; VE2AX; VE2KA; VE2LB; VE3ER; VE3KF; VE3MI; VE3WA; VE3XU; VE4TJ; VK2GU; VK3CP; VO3X; VQ4KSL; VU2AU; ZE1JJ; ZT1R. — W 1ADM; 1ANA; 1ICI; 1IOB; 1ZB; 2EEG; 2FBA; 2JAD; 3JM; 5EHR; 6DOB; 6HB; 6IIG; 6JJU; 6KRI; 8DNE; 8DYE; 8HGW; 8IWG; 8QDU; 9ADN; 9EF; 9KQT; 9LJU; 9TQW

(28 Mc. phone)

VE2CA; VE2KX. — W 1DTJ; 1EKT; 1FZA; 1IDC; 1JH; 2AMF; 2DDU; 2DKJ; 2EBT; 2GFH; 2IJD; 2JIT; 2JUJ; 2KAD; 2KAX; 3AKX; 3BHJ; 3EPV; 3FKK; 3FVO; 3PC; 3ZX; 4EBM; 5CQJ; 6ERT; 6JJU; 8BDO; 8CKY; 8CMW; 8ISC; 9DII; 9EKD.

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Bandswitching Superhet

[*Continued from Page 38*]

forms to R.M.A. requirements and is rather well known, but for those few readers who are not acquainted with R.M.A. standards we might advise that red leads are for B plus, blue leads for plate, green leads for grid or diode, and black leads for ground or a.v.c. connection.

The various leads from the magic eye and the r.f. coil assemblies are likewise coded, and the colors are written in for ready hookup reference on the circuit schematic prepared by the author and published herewith.

A study of the under-chassis photograph should give all other information necessary to the proper wiring of the various components.

Adjustments

1) Voltage measurements should first be taken and the following approximate readings should be obtained: input to CH, 350 volts; input to 1000 ohm speaker field, 330 v.; B plus from the filter, 250-260 v.; 6F6 screen, 245 v.; 6F6 cathode, 16.5 v.; 6Q7 plate, 120 v.; b.f.o. plate, 150 v.; h.f.o. plate, 100 v.; other plates, 240-250 v.; 6K7 and 6J7 screens, 100 v.; mixer screen, 150 v.; mixer cathode, 6 v.; 6K7 cathodes, —3 to —50 v.; 6J7 noise amplifier cathode, 3 v.

2) Tune the i.f. transformers to exactly 456 kc. by means of a calibrated test oscillator. This is the intermediate frequency for which the r.f. coil assembly is designed.

3) Trimmers for the r.f. detector, and high frequency oscillator coils are color coded and are conveniently accessible through holes in the tops of the r.f. assembly shield cans. Those colored red are for the low frequency or general broadcast band (540 to 1400 kc.), those colored brown for the medium frequency range of from 1400 kc. to approximately 4 megacycles. Yellow and green trimmers refer to coils covering the two high frequency bands, 4 Mc. to 10 Mc., and 10 Mc. to 25 Mc., respectively.

[*Continued on Page 52*]

Here are a few random entries sporting somewhat of a modernistic motif.

From Far and Near: High, Wide, and Handsome

Well, the QSL contest is not yet over at the time of this writing, but more than 1000 cards have already been received. RADIO is w.a.s., almost w.a.c. And the cards still are coming in.

Rather than wait till the contest is over and then run all the interesting cards in one "dose", we are going to show in this issue some of the entries that caught our attention. We said that only the winners and a few runners up would be shown; but because of the intense interest shown in the contest and because so many of the cards are just too good not to run, we are stretching a point and showing considerably more.

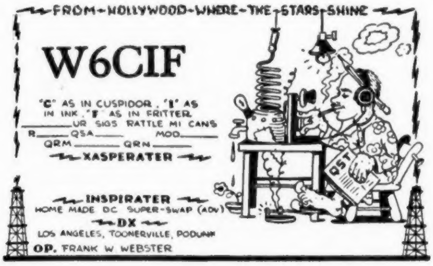
Unfortunately, not all of the best cards received appear in the magazine. Some, like that of W5BDB, are a little too risqué. Others, because of the color scheme, would not reproduce satisfactorily. Others cannot be reproduced (in spite of their excellence) because of the fact that halftone cuts were used in printing the cards, and as it is necessary to make halftone cuts of the cards in order to reproduce them, the reproductions would be very poor, interference lines (heterodynes) appearing across the card or part of the card that was originally printed from a halftone.

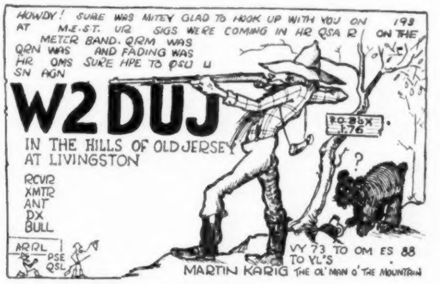
Some very elaborate and showy cards were received from foreign countries, but because of their very elaborateness and beautiful multicolor decorations, cannot be reproduced in black and white in a manner that would do the cards justice.

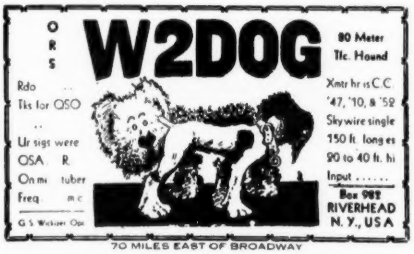
Several very catchy cards were received that rely upon metallic inks and papers for their very striking appearance and distinctiveness. About all we can do with these beauties is admire them ourselves. They would appear very drab if reproduced in the magazine.

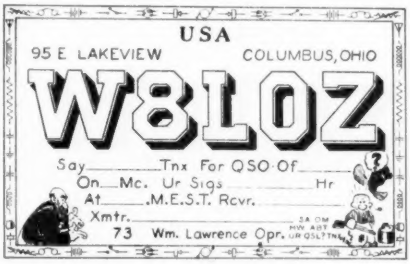
Brickbats, Bouquets, and Babble

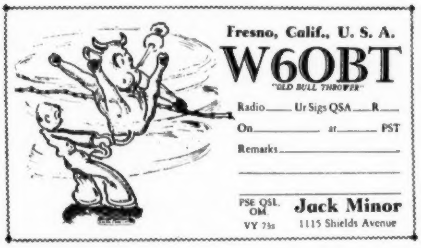
The reverse sides of the cards also are a story. Some very amusing, some very interesting, and many very helpful suggestions were received. From the comments on the cards we hope to be able to give our readers a magazine that will more closely contain what they desire

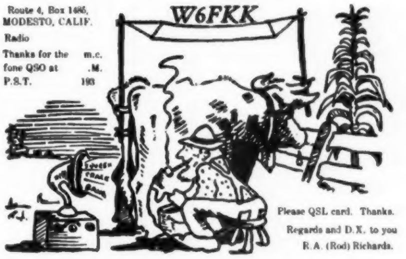


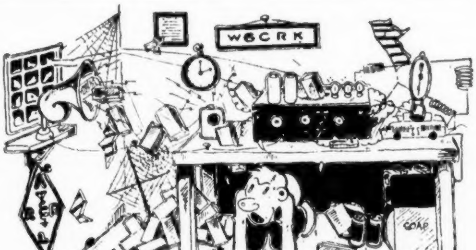


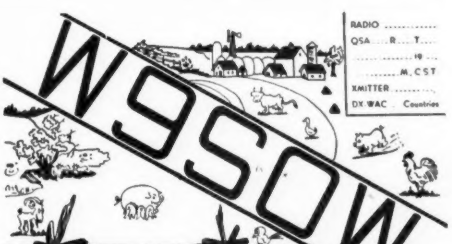










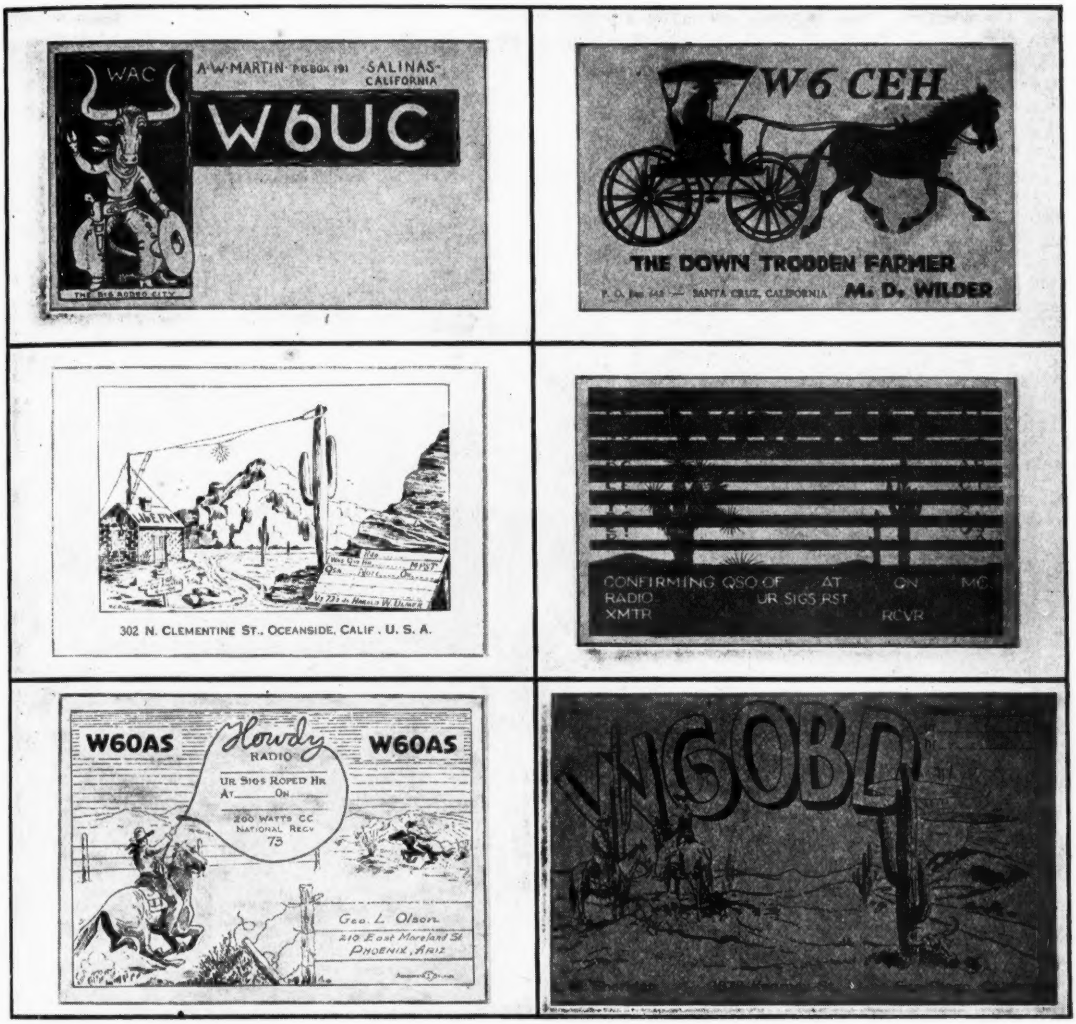


"Ain't he the card, though?" Amateurs referred to in these terms usually have cards such as the above.

in the way of material. It is only through their comments and suggestions that we are able to know just what sort and proportion of material our readers prefer.

The spirit shown in this regard has been very good. Dozens of very plain cards were received on which their owners started their comment with, "I know there is no chance

A few of the many photographic cards received. Unfortunately those using halftone cuts could not be reproduced. As far as we are able to determine, the card of W1CT, Wollaston, Mass., is supposed to be surrealistic.



Six six-cards from the six-shootin' wild-and-wooly West, where cowboys, corn likker, cactus, cattle, and kilowatts are all pretty tough.

whatever of my card winning the contest, but I wanted to offer the following in response to your solicitation of criticism." Not all used those exact words, of course, but the idea was that they were trying to let us know what our readers want—in spite of the fact that they knew their cards did not have a chance as far as winning the contest goes.

The cards received are so excellent that next month we shall run another bunch. The response to the contest has been so good that next year we shall hold another contest.

The judges are going to experience no small difficulty in choosing the winning entries. Their job is a tough one; do not be too harsh with them if you do not agree with their choice.

The winning cards will be announced in the next issue . . . if the judges are able to come to a decision.

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"We see by the papers" that Radio can boast of but two departments. If anyone can tell us how to add up the Editorial department, the Dx department, the "Open Forum" department, the "28 and 56 Megacycle" department, the "Calls Heard" department, the "Postscripts and Announcements" department, the "Hams Across the Sea" department, and the "What's New" department and get *two*, we would like to know how it is done. All of these appeared in the March issue. But perhaps March was not a "typical" issue?

Why Research?

By Chas. F. Kettering*

[Mr. Kettering, while most widely known as a motor vehicle engineer, also is famous for his electrical inventions. He long has employed cathode ray instruments and other electrical tools in solving motor vehicle problems. Few amateurs realize how closely the general spring and shock absorber problem in a motor car resembles a tuned resonant circuit problem with resistance, reactance, and broad frequency response as important considerations. Few amateurs know that Mr. Kettering was one of the first to experiment with artificial fever equipment utilizing high frequency, vacuum tube generators.

Mr. Kettering has long been familiar with the problems and achievements of amateur radio, and all amateurs and experimenters will find many stimulating ideas presented herewith.—Editor.]

A research department is established by a company for one of three reasons. They may feel that a research laboratory is a good thing because they can use it in their advertising copy. Or they may feel that it is something to gamble on; if they spend a little money down that alley, the boys might stumble on something and they might make a little money on it. The third, and more serious thing, is to find out where they are going.

I have often said, "Research is trying to find out what you are going to do when you cannot keep on doing what you are doing now." In other words, it's an insurance policy for the future. It is an attempt to tell what is ahead of the industry and what things we can do to determine, if possible, the trends which this industry may take.

One way of illustrating the relationship of research to industry is this: On the first day of January, somebody gives you a calendar. It has 365 pages in it, and lines upon which you can write things which probably won't come out the way you wrote them. As you tear off these pages the calendar becomes thinner and thinner. I think it is the duty of research in industry to put a new page on the back of that calendar just as fast as you tear one off the front. It must see that that calendar remains the same thickness regardless of the particular date or the year. Research must assure the management that they will not wake up some day and find they have nothing to do.

This calendar story is particularly apt in that it is the passage of time which makes research necessary. As long as the world keeps going around, there will continue to be changes. In this country there are something over 2,000,000 new people coming into the world every year. You can't tell what new ideas are going to come in with them, but you know there are going to be some. Many people are always looking for a stopping place, some place where this continual change will end. The answer to that is that the only resting place on the great road of life is the seat in front of the undertaker's office. You can't stop change any more than you can stop time.

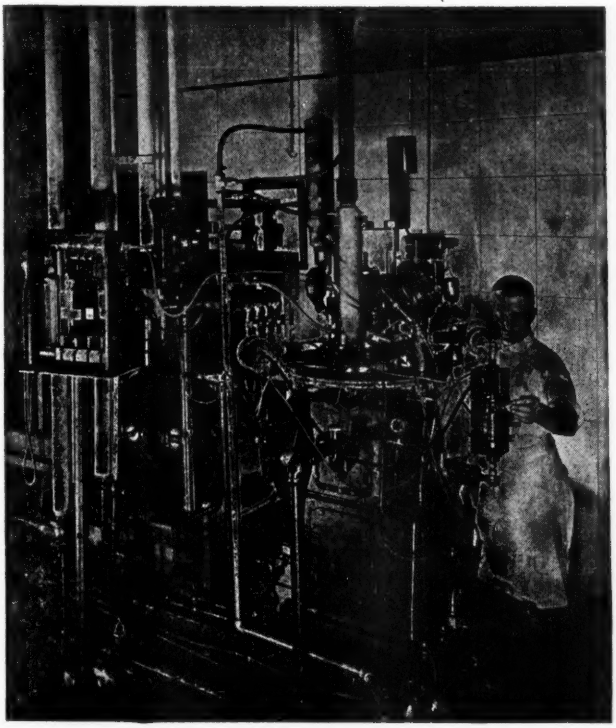
I don't think research has kept up with its duties over the last fifteen years, and the biggest reason for this is that we have become too expert as bookkeepers. Everything is done with one eye on the balance sheet. It will cost so much money to complete this project, and we must have a return of such and such per cent on it.

We don't object to an accounting system. It's a very necessary thing, and I don't blame management for wanting to be consistent and handle everything on the same basis. But a research project just doesn't fit into this set-up. You have to have a different kind of accounting. I mentioned earlier that research was a form of insurance, and in the insurance business they use what is called "actuarial accounting". They don't worry so much about the individual items; they just want to be sure that the average of all the items comes out as they figured. So it is with research. We will take whatever amount of money the management will give us, and we will spend it just as carefully and thriftily as the manufacturing department would. But we won't guarantee that in a month, or six months, we will have produced some definite article which will make a certain amount of money for the corporation. All we can say is that in the long run something will come out of it which will more than repay the money spent. I think the record of any well-organized research laboratory will bear out that statement.

You can't look ahead and say just what you will want to be doing a few years from now. Out of all the past experiences it is impossible

*President and general manager, General Motors Research Corporation.

for us to project industrial developments very far into the future. Some people ask, "What will the next great industries be?" There is no answer to that because nobody knows. You can't recognize an industry when it is starting. Some grow quickly and steadily from the very beginning. Others are held back for years because some particular factor is not developed, and when that appears, the industry may reach tremendous proportions practically over night.



The radio industry is a very good example of this. The principles had been known for many years, and messages were transmitted before the turn of the century. As an industry, however, it was simply non-existent. Then with the development of our present vacuum tubes, it was changed from an experiment and hobby of a comparatively few people to a full-grown giant industry.

It is interesting to note in this connection that in the technical study made by the radio amateurs who sat up all night trying to telegraph across the street we had developed the technicians who became the service men of this new business. The rapid advance of radio was due to a great extent to the ready availability of these trained men who had been amateurs. They were self-educated. Did they study radio because they wanted to go into the business? No, they didn't know it would ever be a business. It was something they wanted to do. It was an adventure. What did they expect to get out of it? They had no idea. It was something that looked like it needed to be done and they wanted to do it. Thus the stage was all set, and when the final detail was added, there was no obstacle to keep from the public the apparatus and service they so quickly demanded.

This same attitude is true of many inventions. Most of the great inventions were not developed consciously. Some fellow wanted to do something and he didn't know why—just to satisfy curiosity, maybe. There are still people who are curious. The trouble is that the opinion seems to be growing that you have to put up a big building and buy a lot of apparatus before you can do any research work. That is fundamentally wrong. If you solicit technical help with your problems, the helper is quite likely to pull a slide-rule out of his pocket and say, "That won't work," before you start the experiment. Maybe he's right, but be sure his statement is based on factual evidence, not opinion.

Remember that you do not solve problems with a laboratory and its equipment. They are only tools, a method of arranging certain brain cells, machinery for getting through about one-eighth of an inch of the most dense material in the world. The problem is solved inside your head, but it is of no use to anybody until it has penetrated the skull.

We had an interesting case of this kind not long ago. I asked one of the boys to work on a little project for me, and I didn't hear anything about it for quite a while. I inquired, and pretty soon this engineer came to me and said, "I'll need some new equipment for this work. Here's the list. It amounts to 480 dollars."

I thought I'd try him out a little. "You're sure you need all this?"

"Yes," he said, "I've figured it all out."

"Suppose you had originated this thing yourself, and weren't connected with any laboratory. What would you have done?"

"I would have started working on it."

"But what would you have done for apparatus," I protested. "You wouldn't have the 480 dollars."

"I'd find some way of making a try at it."

"All right," I said, "You go back and make a try at it now."

He came back in two days, grinning. "I need 46 dollars worth of apparatus," he said.

"Fine. I don't think there's any question but what you need that. Incidentally, you have done some really valuable thinking, for in 48 hours you have thought about 430 dollars worth."

In my opinion, the best way to start doing research, whether a large or small company, or even an individual is concerned, is this: Take a piece of paper and write down the problems that are bothering you, say eight or ten of them. Think about the first one a while; if you don't get anywhere, try some of the others. It's like a cross-word puzzle, you pick out some place where you can get started, and what you do there gradually helps you in solving some of the other parts. You can't hire a man, put him off in a corner with some equipment, and say you have a research department. You must analyze your problems first. How do you know what kind of equipment you will need? You may start out thinking your problem is one of design, and it finally comes down to a question of metallurgy. Or it may even end up a matter of economics.

That is where the worker in an industrial research laboratory differs from the so-called "pure science" man. You are always hearing discussions and comparisons of pure science versus industrial research. The worker in the former field is quite likely to have a very poor opinion of the man who lowers himself to work for industry on a salary basis.

But let us analyze the situation a little. The pure science man has to consider only two things, material and energy relationships. That is all he has to work with. In industry, however, the research man has these two factors, and also the factors of economics and psychology. Is the public going to like it? Can you build it for a price people will pay? Maybe it would cost you 100 dollars to build an article as you believe it should be built; but for 25 dollars you can produce one which is 90 per cent perfect. Is it economically feasible to spend that additional money? That is the type of question which must always be considered in industry. In other words, you have all the complications incident to four basic factors instead of two.

After all, however, such distinctions do not matter a great deal. Scientists, engineers, research workers, or whatever terms you wish to apply to them, are all striving toward a common goal. They are all attempting to increase our knowledge, to accelerate progress, and the result of all this is to make the world a better and more comfortable place to live in.

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Bandswitching Superhet

[Continued from Page 45]

The circuits are conventionally aligned at the high frequency limits by trimmer adjustments. Alignment at low frequency limits for the two short wave bands is similarly effected. Low frequency alignment for the b.c.l. and medium ranges will call for adjustment of the padders at the back of the coil assembly.

4) With the b.f.o. off, tune in a fairly strong local signal. The tuning eye will close almost completely at resonance.

5) Turn on the b.f.o. switch and adjust the transformer trimmer until a beat on c.w. is had which does not seriously affect the a.v.c. If after several adjustments for a suitable beat strength the 6G5 indicates an inacceptable lowering of receiver sensitivity, try some of the a.v.c.-off switching schemes previously suggested.

The beat coupling capacity to the 6L7 i.f. plate might very well consist of a few insulated turns of wire wrapped around the blue lead from the output i.f. transformer.

6) Now get down below 20 meters and pick up some really high level QRM of the automobile ignition and electric motor variety. With the noise control advanced, adjust the noise transformer trimmers until maximum attenuation of the unwanted impulses is had. By the way, don't let the noise circuit oscillate. If it does, the generated r.f. might build up a rather heavy voltage across R_{36} which will go directly into the 6L7 injector grid and no doubt bias that tube to complete cut-off.

◆

After marveling at the f.b. quality of a live cat's ear used as a microphone in a recent demonstration at Harvard Medical School, we shouldn't be surprised if there is a neighborhood cat missing for each new good quality ham phone.

◆

Though the 9th Call Area is well into three-letter Z assignments, they haven't bothered themselves about three-letter Q's there. The 8th Area has. (Tnx to W9GPL for this one.)

A Simple "Signal Squisher"

By W. W. Smith, W6BCX

Some like to get behind the steering wheel of an auto; some like to get behind a machine gun. Others like to get a hand on a boat tiller; others like to get a hand on a "signal squirter".

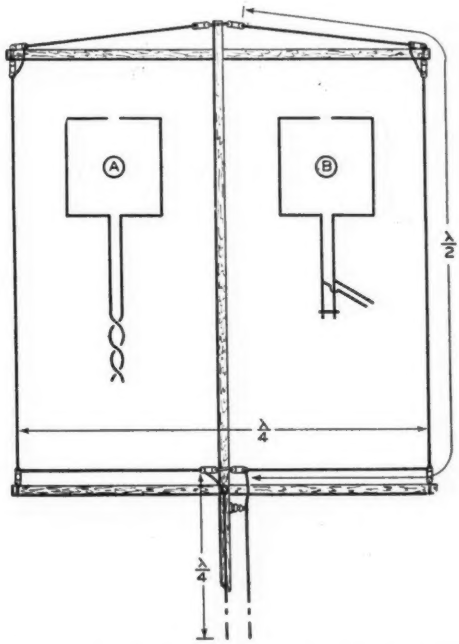
There is something fascinating about steering mechanisms, where the device follows the will of the operator. Perhaps that is why so many rotatable 20 meter arrays are in use. There is certainly room for argument as to whether or not it is possible to get worthwhile gain from an array small enough to be rotated. However, they are helpful in cutting down QRM and do assist in receiving. In fact, a simple array with only 2 or 3 db gain in the favored direction when transmitting may present as much as 10 db improvement when receiving. The Reinartz rotary beam is a good example of the latter. The reason for this is that an array may have high discrimination and front-to-back or front-to-side ratio, and yet show but little gain over a reference antenna when transmitting. Using the array for receiving, the "gain" over a reference antenna is not so important as the discrimination (sharpness of the response lobe or lobes).

Even so, the slight increase given by simple arrays when used for transmitting represents a considerable increase in "effective power". An increase of only 3 db is equivalent to doubling your power, which, if you are using more than 500 watts, would cost more than a simple rotatable 14 Mc. array.

The gain from simple arrays is oftentimes much greater than one would be led to suspect. The reason for this is that the array is also concentrating the radiation at a more favorable *vertical* angle.

Many will argue that unless one can put up an elaborate array, an array too awkward to rotate when cut for 20 meters, one might just as well use a vertical "Q", high and in the clear. Maybe they are right, but for those that don't agree, and for those that like to "aim" things, the following is presented as an addition to the list of signal sprinklers, slightly different than those now in common use.

The device is compact, easily constructed for 10 meters and not too difficult of construction for 20 meters. It is bi-directional and shows



The Array is Bi-directional, Along the Line of the Cross-arms (End Fire).

good directivity for such a simple array, the radiation broadside being practically nil over quite a few degrees. It also confines the radiation to a very low vertical angle.

The array is nearly square, though slight variations in the proportions are not important, just so it is rectangular and the elements are exactly a half wave long, or about 17 feet for the center of the 10 meter band (29 Mc.). The matching stub should be about $8\frac{1}{2}$ feet long for the same frequency.

The stub may be fed either with an open 400-600 ohm line, or a 70 ohm twisted-pair cable. The former is preferable, as the twisted pair has considerable loss at 10 meters. However, if the array is built on the roof of the shack directly above the transmitter, it is possible to get by with such a short enough length of feeder that the losses are negligible.

The connections for the twisted pair are shown at "A". The method of matching an open line is shown at "B". The procedure for adjusting the shorting bar and the position of

[*Continued on Page 57*]

"A Section At a Time"

By H. Rexford Brokaw,* W6COO

The main reason for using towers instead of poles for heights over 60 feet is that longer "sticks" are usually so floppy that it is difficult to raise a length that necessitates manipulation of more than one set of guys during the raising. This difficulty can be eliminated by raising the pole in two sections, as explained in W6COO's article.

Most amateurs are agreed that the best transmitter in the world is just as good as the antenna and no better. Increasing interest is being shown in "the most suitable type of antenna". While a matter of a few hundred dollars may be spent on a transmitter to increase power, few amateurs think of spending a little money to improve the effectiveness of their antennae. One of the most important factors is the altitude of the sky wire, and that altitude generally is dependent upon the masts, unless the operator is fortunate enough to be located near tall trees, or other high objects.

The erection, then, of an economical and easily constructed antenna mast should be a matter of concern with many amateurs. Several articles have been written lately regarding lattice masts of both the guyed and self-supporting types; but where space is available for guy wires, the mast shown in the illustrations fills the essential requirements quite nicely. As for simplicity, it may be completed in one day, disregarding painting. (Painting is highly recommended.) It is comparatively inexpensive, since ten dollars will cover the bill for materials for the construction of an eighty footer.

Materials

The first step in construction of such a mast is the selection of materials. The uprights are made of clear Oregon pine two-by-fours. The sticks should be cut preferably from rough lumber, rather than finished two-by-fours, in order to obtain sticks that will net approximately two-by-four inches after finishing. In finishing these sticks, they should be run through the planer and barely cleaned, taking off as little as possible of the rough surface. This will give uprights that are somewhat huskier than the regular run of two-by-fours, which will net about $1\frac{1}{2}$" by $3\frac{1}{2}$" after finishing. If possible, obtain these uprights in 30 or 32 foot lengths. Shorter lengths may be used, but will require more joints, and more guy wires, as guys should be attached at the joints to give the greatest strength against winds.

The cross braces can be made of ordinary two-by-fours as no extraordinary strength is necessary here. Two braces of one-by-two are needed to square up the lower frame. Two redwood, cypress, or cedar four-by-fours are required for footings at the base of the pole. Other materials could be used for these by impregnating with creosote in order to prevent decay or attack by termites.

The only additional materials are a quantity of no. 10 galvanized guy wire, strain insulators, bolts, nails, and screws.

Assembly

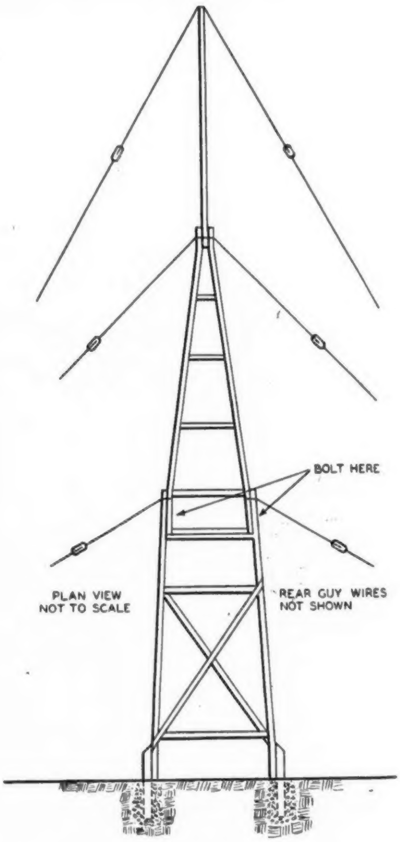
In assembling the mast, it is best to lay the whole thing out on a flat surface such as a sidewalk, driveway, or the like. In this way, the sides are easily made straight and the whole mast may be lined up, so that erection consists merely in assembling the various units.

The correct spacing is determined for the top and bottom of the lower "A" frame, and the various cross members tailored to fit, being careful to keep the sides straight at all times. These cross members are fastened with two spikes, or better yet, two large wood screws. The second, and possibly the third, "A" frames are assembled in the same manner with the bottom of the upper frames fitting *inside* of the lower frames. An overlap of two feet should be made at each joint and holes should be drilled for two $\frac{3}{8}$ inch bolts. The best method is to assemble all sides first, and put in the cross members afterward. The last part of the assembly consists in fastening the diagonal braces in place to keep the lower frame square during the process of erection.

Painting

When the whole mast has been assembled in this manner, the bolts should be removed from the joints, leaving the whole in two or more units. This is also a good time to apply a generous coat of weatherproof paint to prevent cracking of the wood from sun and rain. A good quality of paint containing lead and oil should be used, rather than some of the cheaper grades made of whiting, etc., which will peel off in a

*271 Spruce St., Pacific Grove, Calif.



short time. It is somewhat of a job to give a second coat after the pole is in the air, so do a good job the first time.

Guys

While the paint is drying is a good time to assemble the guy wires. Strain insulators, preferably of the so-called airplane type, should be placed in the guys at intervals of approximately 12 feet, as this spacing gives a length which is not in harmonic relation to any of the shorter wave bands, and excitation from the lower amateur frequencies would be too small to consider. If the mast is to be used only for the 160 or 80 meter bands, longer intervals may be allowed between insulators, as long as the spaces are determined as above to stay away from harmonic relationships (especially the second and third harmonics). Three guys are required at each joint; these should be attached directly over the lap, between the two bolts. Also one set is required for the top of the pole. The upper end of each guy should be broken up at half the interval decided upon; otherwise the combined length of two sections after assembly will be twice the length desired.

Two holes should be dug in which to sink the footings for the mast, spacing them so the mast will straddle the two four-by-four footings. Make the holes just large enough so that the posts will fit loosely in them, and set the posts at an angle that will line up with the sides of the mast. They should be left loose until the first section of mast is erected, inasmuch as the mast is tapered and would not pivot otherwise.

This is the time to make a careful check of the construction completed so far. Everything being ready for the actual erection of the mast, it would be advisable to call in several of your friends and raise the mast on the "steam beer plan". (The x.y.l.'s serve a plentiful supply of suitable nourishment and beverages when the work is done, and *not* before!)

Procure sufficient rope to make four guys for the lower section, and if you have sufficient rope it is advisable to guy the middle of the lower section in order to steady it while erecting the upper part of the mast. Bolts are placed through the bottom of the mast to act as pivots during the erection process, and as anchors later.

These should be loose to prevent binding. If the guy wire anchors are all located, everything is ready for the big push. Take ample precautions during preparation as this only goes up once, or else.

Up She Goes

Now with some pulling on guy wires and some pushing on the mast, this section goes up readily, and should be firmly anchored with the *ropes* only. *Do not* attach the guy wires yet. The whole should be squared up, dirt packed in around the footings, and footings firmly bolted to the uprights.

The lightest and bravest member of the gang now should climb to the top of this section, to attend to coupling sections and attaching guy wires. The upper two sections should be completely assembled, including pulleys and rope for raising antennae, and pulled up vertically alongside the first section. A block and tackle is useful at this point for raising these sections into position. There should be a cross piece *on the bottom* of the second section and another *bolted on the side* at the top of the first section. The tackle is coupled as close to the center of these two cross pieces as is possible, in order that the blocks will not interfere when they are pulled together. There is a two foot overlap at the joint, and these blocks must allow at least this two foot minimum to be obtained.

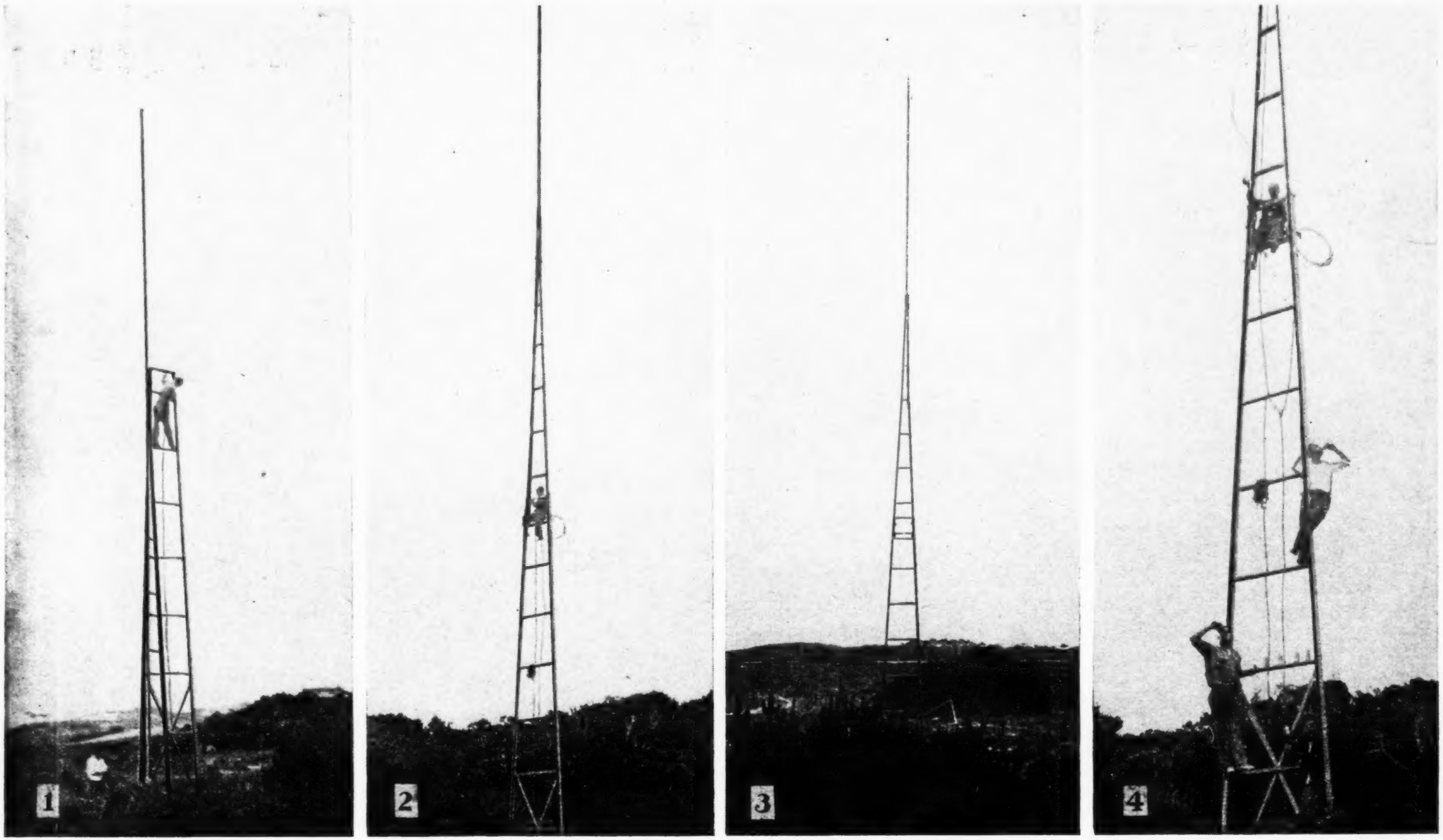


Figure 1 shows the bottom section guyed in place and the top section raised on the ground. Figure 2 shows the top section being bolted into place. Figure 3 shows the completed job, and Figure 4 the "steam beer" method of pole raising.

With one man on top of the lower section, two on the tackle rope at the bottom, and at least three to watch the guys, you are ready to hoist into position. Take your time, and let the fellows at the bottom give instructions to keep the top straight. Those on the guys are each sure the mast is falling away from him, and unless one man at the bottom gives instructions, each one will be pulling the mast toward himself, with the result that much extra and needless straining is done.

When this section reaches position, the man on top should insert the bolts into the holes and fasten the sections together. Now is the time also to attach those guy wires, circling them *around the splice,* as all other guys should be. Get all the bosses out now, and line up the mast and secure the guy wires. There will be plenty of free advice at this point. It is advisable to insert turn buckles in the guys, within reach of the ground, in order to take up slack which is bound to occur. Put some heavy machine oil on the turnbuckles to keep the threads from "freezing".

If you have followed these instructions explicitly, you should have an eighty foot mast with no grief encountered. Additional height may be obtained by inserting another "A" frame between the first and second sections, this being accomplished by raising it alongside the lower section, raising the two upper sections previously joined, and after coupling the three upper sections together, raising them vertically as a unit to couple to the lower section. This may require more care and more hands during the hoisting, but will be worth the extra effort, and just as rigid when finally anchored.

Just a word in conclusion. Use good galvanized guy wire, at least no. 10, and waterproof the pulley ropes with creosote or linseed oil. It is quite a task to replace a rope or guy at a later date; so use good material to start. Advantage can be taken of the upper guys also, by splicing in antennae, such as 20 and 40 meter dipoles, in order to give several directions. These should be made of copperweld wire, and insulated with *heavy* antenna insulators to avoid possibility of breakage. Other possibilities may also suggest themselves to the reader for using a mast of this type to great advantage, such as beams of the curtain variety for 10 and 20 meters, which may be cut into the various guy wires.

May all your reports be "QSA5 and R9 plus!"

"Signal Squisher"

[*Continued from Page 53*]

the feeders on the stub is described elsewhere in this issue in the "J" antenna article by Hawkins.

Mechanical Construction

The 10 meter array can be constructed from a 20 foot length of 2 x 2 for the vertical and two 9 foot lengths of 1 x 2 for the cross-arms. The assembly will be a little "floppy" but the wires will hold it rigid enough, and heavier material is not needed unless high winds are expected.

The stub should run down the pole on stand-off insulators about 2 inches from the wood. The stand-off insulators should be spaced in pairs about every 18 inches. They should be mounted on *adjacent* sides of the vertical pole, and *not* on opposite sides. If they were placed on opposite sides of the pole, the pole would introduce more dielectric loss. Besides, placing them on adjacent sides gives just about the right spacing for the stub to match a twisted pair if such a feeder is used. If the open line is used, the spacing of the stub is unimportant, though the dielectric loss still is.

As the array is bi-directional, it is necessary to swing the affair through only 180 degrees instead of 360. Even so, the problem of guying the thing so that it is free to rotate through a 180 degree arc is somewhat of a problem. The solution will depend upon the individual installation, and for that reason is left to your ingenuity. Quarter-inch oiled rope is preferable to wire for guys, as it does not distort the radiation pattern as do guy wires.

◆

W1HSV was listening to himself in his monitor phones one evening. He cut the r.f. portion of his signal squirter and could still hear himself talk. He cut the modulator and speech and still his voice came through. Nor did shutting off the monitor itself kill the talk. He traced the baffling phenomenon to headphone diaphragms which vibrate on sound conducted through the bony structure of the head (no reflection, Jack!) and through the earpiece cases.

◆

A Cleveland man is named *C. W. Watt,* while *R. F. Short* also lives in Cleveland. *M. A. Current* lives in Dallas.

Stabilized Feedback for Radio Transmitters

By L. G. Young*

The output of a perfect radio transmitter, properly rectified and adjusted for volume, would be found to be an exact copy of the speech or signal on its input side. For any actual transmitter, however, the output is found to differ somewhat from the input in three respects. In the first place, the amplitudes of the input and output waves will not maintain the same relative values as the frequency of the input voltage is varied. The second difference is the presence of noise in the output that is not present in the input signal. This noise is principally a hum due to the use of alternating current as the primary source of power for heating the filaments, biasing the grids, and energizing the plate circuits. The third difference between output and input lies in the wave form. When a single-frequency wave is applied to the input, the output includes the harmonics of this frequency as well as the fundamental itself, and thus has a different wave form.

The first of these differences is not usually serious, since the frequency characteristic of a broadcasting transmitter can ordinarily be made flat to 1 db over a range from 50 to 10,000 cycles by the proper selection of the low-power audio-coupling circuits, the cost of which is generally less than 1% as much as that of the transmitter. The other two differences are much more formidable, and before the advent of stabilized feedback could be satisfactorily reduced only at considerable expense.

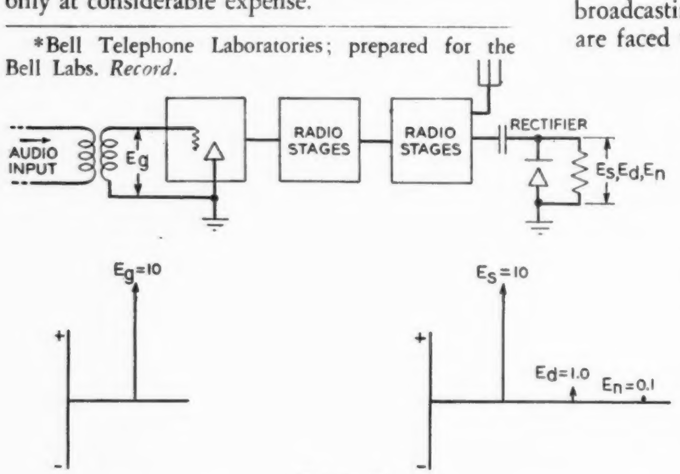


Figure 1

In the output of a radio transmitter there are certain components in addition to the desired signal. These are chiefly a distortion component and a noise component.

The greater part of both the noise and the distortion arises in the final amplifier stages. To reduce the hum, direct-current generators have commonly been employed to supply the filaments, using filters to minimize the commutator ripple. For a 500-kw. transmitter, however, a current of some 5000 amperes at thirty volts is required, and the cost of these generators, which must generally be supplied in duplicate, plus the expense of their maintenance becomes considerable. The harmonic distortion, on the other hand, is caused chiefly by the nonlinearity of the final amplifying stage. The input-output characteristics of vacuum tubes are not linear up to the limits of their power output, and if to avoid the distortion the tubes were used over only the straight part of their characteristics, considerably greater power would have to be provided in the final stage.

In the past, engineers have incorporated sufficient tube capacity in the final stage to keep the distortion within tolerable limits, but the initial and operating cost of the transmitter has been proportionately increased. Recent revisions in the standards of performance demanded of radio transmitters have set the requirements on permissible distortion to so low a value that for very large transmitters it becomes economically impracticable to secure sufficiently low distortion by these means. With the increasing size of broadcasting transmitters, therefore, designers are faced with what has seemed the almost impossible task of securing low noise or hum and low harmonic production at a practicable cost. Fortunately, the development of stabilized feedback by H. S. Black has pointed an easy solution. So effective is this new development that the filaments of the tubes may be heated directly from alternating current, and the final amplifiers need only be large enough to carry the modulating peaks, and yet the hum and distortion may be kept well below all likely requirements.

A very much simplified schematic of a radio transmitter might be represented as shown in figure 1, where a rectifier is connected to the final

*Bell Telephone Laboratories; prepared for the Bell Labs. *Record*.

stage so that a portion of the output will be available for comparison with the input. For simplicity it may be assumed that the input is a single frequency, and under these conditions the input and output voltages could be represented as shown in the lower part of the illustration —the amplitude of the rectifier output being adjusted so that the fundamental frequency has the same value as that of the input to the transmitter. This input voltage is marked E_g, and the corresponding output voltage of the rectifier, although made equal to it by adjustment, is marked E_s to indicate that in general it is different from that on the grid of the input stage. Two other voltage vectors are indicated in the output—one, E_d, representing the distortion voltage, and the other, E_n, representing the noise voltage that is generated within the transmitter itself.

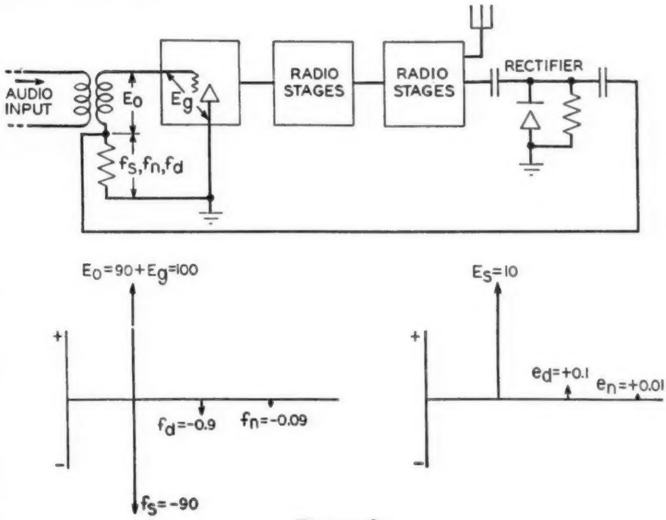


Figure 2

Feedback returns to the input a portion of the output in reverse phase, and in this way cancels part of the output noise and distortion.

Although E_d and E_n are actually generated within the transmitter, and in fact, practically always in the final stage of the transmitter, the effect is exactly the same as if these voltages were produced at the grid of the first tube, and the rest of the transmitter were free from distortion and noise. Thus if equivalent voltages 180° out of phase could be introduced into the grid circuit of the first tube along with the signal voltage, the distortion and noise would be cancelled out and the transmitter would be perfect. The principle of feedback is thus to carry back to the input of the transmitter a portion of the output in reversed phase, so that the distorting elements in the output will be cancelled by similar but negative voltages. Actually, of course, the full value of the distortion cannot be completely cancelled, for if it were there would be none of the distortion remaining in the output to be fed back. There must always remain a vestige of the distortion in the output that may be adjusted to the proper value and then fed back to the input.

The various relationships involved may be illustrated for the moment by considering the harmonic distortion alone, and assuming that without feedback the distortion was 10% of the signal in amplitude, and that it is desired to reduce it to 1% of the signal, or to one-tenth of its former value. This ratio of final to initial distortion defines the amount of feedback required. The distortion under feedback conditions will be equal to the original distortion plus the distortion fed back, which is in phase opposition to the original distortion, and thus the amount of distortion to be fed back will be equal to the difference between the original and final distortion. Thus, if the original distortion was 1 volt and the final distortion is to be one-tenth of that amount, or 0.1 volt, the amount of feedback will be —0.9 volt, or nine times the final distortion and in opposite phase.

The feedback circuit, however, picks up not only the harmonic-distortion components but the noise and the signal components as well, and all will be reversed in phase and equal to nine times their final values in the output circuits. The purpose of feedback, however, is to reduce the noise and distortion without reducing the signal, but it is obvious that if a signal nine times the original and in opposite phase were fed back, the amplitude of the input signal would have to be changed in order to keep the output signal the same. In other words, the input signal amplitude must be increased so that when combined with the feedback signal, the sum will just equal the original input. Since the signal fed back in the example taken is minus nine times the output signal, the increased input signal must be ten times the original signal in order that the difference will give the same signal amplitude as existed before feedback was applied. If the original signal was ten volts, the signal feedback will be minus 90 volts, and the increased input signal must be

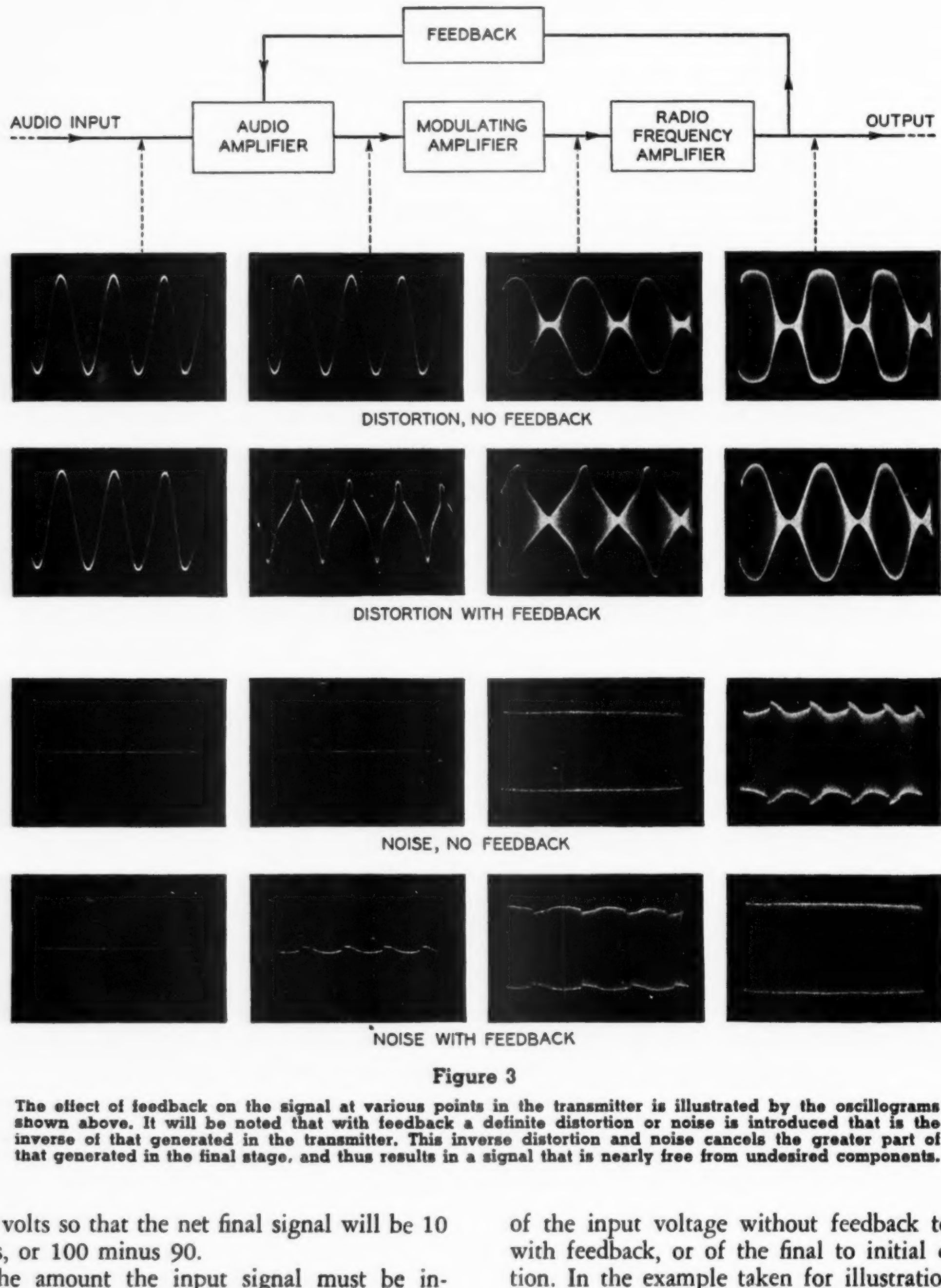


Figure 3

The effect of feedback on the signal at various points in the transmitter is illustrated by the oscillograms shown above. It will be noted that with feedback a definite distortion or noise is introduced that is the inverse of that generated in the transmitter. This inverse distortion and noise cancels the greater part of that generated in the final stage, and thus results in a signal that is nearly free from undesired components.

100 volts so that the net final signal will be 10 volts, or 100 minus 90.

The amount the input signal must be increased under feedback conditions, or the ratio of input voltage without feedback to input voltage with feedback is numerically equal to the ratio of distortion voltage with feedback to distortion voltage without feedback, and for convenience is taken as the measure of feedback. The amount of feedback in db is thus twenty times the logarithm of the ratio either of the input voltage without feedback to that with feedback, or of the final to initial distortion. In the example taken for illustration this ratio is ten, and thus there may be said to be 20 db of feedback.

In figure 2 is shown the same transmitter as in figure 1, with the addition of the feedback circuit, and below it are the various voltages under feedback conditions. Small letters are used to indicate the reduced values of the noise and distortion voltages. The noise voltage with

feedback, is in the same ratio to the original noise voltage as the distortion voltage with feedback is to the original distortion, all forms of distortion being reduced the same relative amount.

In practice, the phase difference between the input and feedback voltages can be made 180 degrees at one frequency only and the simple, ideal condition just depicted is not realized. It is the problem of the transmitter-circuit designer to control and manipulate the phase shifts and gains throughout the circuits involved so that the feedback and input voltages do not become in phase except at frequencies far removed from the transmitted band. The gain of the feedback loop at these frequencies where the voltages become in phase must be reduced to less than unity or singing will result. It is not always easy to apply feedback to a radio transmitter, but the results obtained with this arrangement cannot be achieved by any other known means which is as simple and economical.

The oscillograms of figure 3 show how feedback action deliberately predistorts the audio signal impressed upon the grid of the tube at the point of feedback, and how this predistorted wave, which is in a sense the inverse of the distortion generated within the transmitter, is applied to the various stages. In the case of this particular transmitter, the distortion and noise were purposely made high to portray more vividly the action by means of oscillograms, and, because of the limitations of oscillograms, the change in voltage amplitude associated with the grid circuit where the feedback action occurs has been purposely omitted.

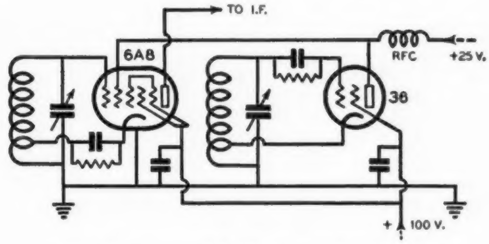
Since the frequency characteristics of radio transmitters are highly satisfactory without feedback, the action of feedback in this respect will not be discussed other than to mention that its application also flattens any irregularities of this nature that may exist in the transmitter.

The great advantage of feedback is obvious once its action is understood. The improvement it gives as a result of the large reduction in noise and distortion with a minimum of additional apparatus is of value to listeners as well as to the broadcaster. Of particular importance to the operators of the transmitter, however, is its extreme simplicity. Stabilized feedback is inherently automatic; regardless of the type of distortion or noise generated, the reduction will always be the same without any adjustments being necessary. With a non-automatic method of correction, every change of condition in the transmitter, such as a change in tubes, will require a readjustment, while with stabilized feedback, once the original adjustments have been made at the time the transmitter is installed, no further attention is required.

A Trick 6A8 Converter

By Ernest Jeppesen, W7DBY

There are undoubtedly many hams who wish to operate a super-het receiver having no r.f. stage on 10 meters. The majority of schemes that have been suggested for accomplishing this with good signal strength and low interaction



The Revamped 6A8 Converter Circuit

have required the use of a high-powered, high-frequency oscillator with its attendant drift and cross coupling. Here at W7DBY it was desired to try a different system.

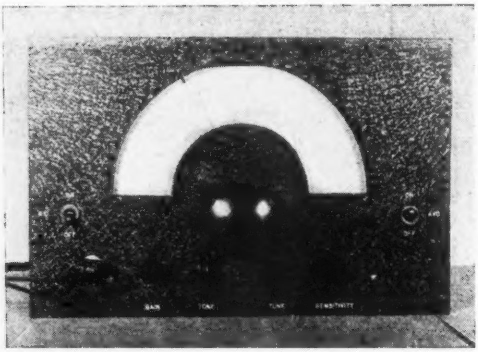
The first attempt was made with a 6L7 converter tube and a 36 electron-coupled high-frequency oscillator with 135 volts on the plate of the 36. Signal strength was very poor.

Upon hearing the report that a 6A8 would operate on 28 Mc. with the oscillator voltage on grid no. 1 and the signal on grid no. 4, this was given a whirl. The results were very little better.

After looking at the tube diagrams it seemed that the 6A8 was built about the same as the 6L7 except that the 6A8 had two grids between the cathode and the screen. So, why not put the signal on the most sensitive no. 1 grid, the oscillator input on grid no. 2, and tie the no. 4 or normal control grid to the screen? The results obtained were excellent. The signals came up from R3 to R8 and 9 and there was no increase in noise level. There was actually sufficient oscillator voltage for good conversion on 10 meters even with zero voltage on the plate of the 36. Oscillations were, of course, maintained by the screen voltage on the tube. Best results were obtained with about 25 volts on the plate of the 36 h.f. oscillator.

Performance, Economy, and Simplicity, Inc.

By R. C. Higgy, W8LFE



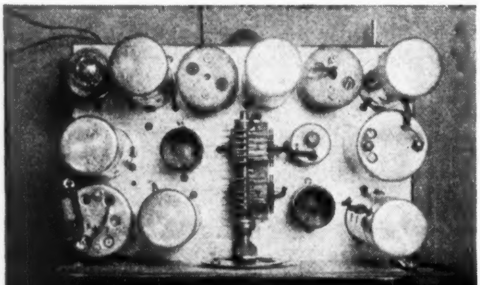
Front View of the Amateur Superhet

What with all of the elaborate receivers available and in general use today, many of us overlook the fact that good reception, dx and otherwise, can be obtained on a relatively simple receiver. Truly the evolution of the amateur receiver from the one tuber to the fourteen or more tube communications receiver has been a magnificent development, so much so that it is easy to forget ourselves and connect good reception only with an elaborate receiver. After all, fancy knobs, dials, and other gadgets are fine business when we can have them, but not essential to good reception.

A few months ago it was decided a new receiver would be necessary for the summer cottage to keep in touch with activities during vacation days. The result was a simple, inexpensive, easily-built receiver with many of the conveniences of a more elaborate receiver. Its performance has been a pleasant surprise, good sensitivity and selectivity with a very favorable noise level combining to really bring in the stations in the crowded amateur bands. During the summer months this receiver brought in readable 20 meter phone signals on a loudspeaker from 42 countries; not a record, to be sure, but an indication of its ability.

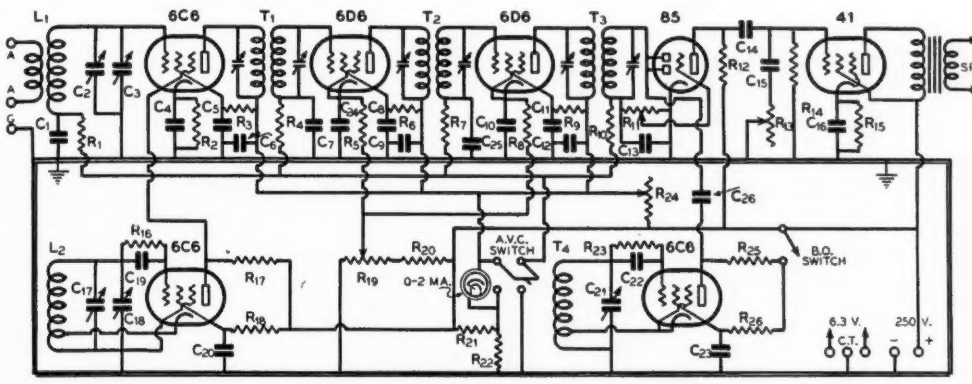
This design uses many time-proven ideas with several somewhat unusual arrangements. The tube lineup is not at all unusual but one that has proven itself. The dial arrangement, though quite different, is one that gives extreme operating convenience and is inexpensive and easily installed. The use of suppressor grid oscillator injection gives a real smoothness of operation with an unusually low noise level. The band spread arrangement is simple, easily adjusted, and capable of giving exact tracking over the whole band with single-control tuning. And, last but not least, there is included a real R meter that reads, as any good meter should, upwards with an increase in signal intensity.

Figure 1 is the circuit diagram and shows a 6C6 first detector; a 6C6 electron-coupled, high-frequency oscillator; two 6D6 i.f. stages (465 kc.); an 85 second detector, a.v.c., and first audio; a 41 audio output stage; and a 6C6 beat frequency oscillator. The design here shown uses a separate power supply with an 80 rectifier. Note the use of both an audio and an i.f. gain control. These two controls, with the switch for cutting on or off the a.v.c., give a flexible arrangement usable under all kinds of receiving conditions for both phone and c.w. Just the desired amount of a.v.c. action can be obtained by setting the i.f. gain or sensitivity control to give the maximum gain desired with no signal and using the audio volume as the manual control. Complete manual control can be obtained by switching off the a.v.c. and using either the audio or i.f. control. The minimum between-carrier noise condition prevails with audio volume at maximum and using the i.f. sensitivity control for the manual control.



Top View of the Receiver

The use of suppressor grid injection of the h.f. oscillator signal has proven in this design to be much better than either control or screen grid injection. All three systems were tried. The



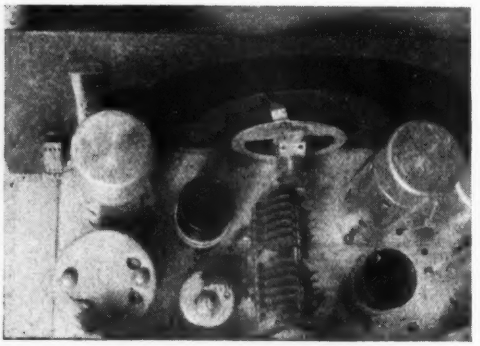
Wiring Schematic of the Superheterodyne

C_1—.05 μfd., 400 volt tubular
C_2—100 μμfd. band-set midget
C_3, C_{18}—Dual 35 μμfd. midget
C_4—.05 μfd., 400 volt tubular
C_5—.05 μfd., 400 volt tubular
C_6—.5 μfd., 400 volt tubular
C_7, C_8—.05 μfd., 400 volt tubular
C_9—.5 μfd., 400 volt tubular
C_{10}, C_{11}—.05 μfd., 400 volt tubular
C_{12}—.5 μfd., 400 volt tubular
C_{13}—.001 μfd. mica
C_{14}—.05 μfd., 400 volt tubular
C_{15}—.05 μfd., 400 volt tubular
C_{16}—10 μfd., 25 volt tubular
C_{17}—100 μμfd. oscillator band-set
C_{18}, C_3—Dual 35 μμfd. midget
C_{19}—.00025 μfd. mica
C_{20}—.01 μfd., 400 volt tubular
C_{21}—B.F.O. adjusting condenser
C_{22}—.0005 μfd. mica
C_{23}—.01 μfd., 400 volt tubular
C_{24}, C_{25}—.05 μfd., 400 volt tubular
C_{26}—2" twisted hook-up wire
R_1—100,000 ohms, ½ watt
R_2—1000 ohms, 1 watt
R_3—100,000 ohms, 1 watt
R_4—100,000 ohms, ½ watt
R_5—1000 ohms, 1 watt
R_6—100,000 ohms, 1 watt
R_7—100,000 ohms, ½ watt
R_8—800 ohms, 1 watt
R_9—100,000 ohms, 1 watt
R_{10}—1 megohm, ½ watt
R_{11}—250,000 ohm potentiometer
R_{12}—250,000 ohms, 1 watt
R_{13}—250,000 ohm potentiometer
R_{14}—250,000 ohms, ½ watt
R_{15}—400 ohms, 10 watts
R_{16}—100,000 ohms, ½ watt
R_{17}—50,000 ohms, 1 watt
R_{18}—100,000 ohms, 1 watt
R_{19}—15,000 ohm potentiometer
R_{20}—75,000 ohms, 2 watts
R_{21}—2000 ohms, 1 watt
R_{22}—100,000 ohms, 1 watt
R_{23}—100,000 ohms, ½ watt
R_{24}—1000 ohm potentiometer
R_{25}—100,000 ohms, 1 watt
R_{26}—250,000 ohms, 1 watt
L_1, L_2—See coil table
T_1, T_2, T_3—465 kc. mica tuned i.f.'s
T_4—B. F. O. oscillator coil

suppressor injection gave much better performance and smoother operation with much less background noise.

Two i.f. stages have been used to provide adequate sensitivity and good selectivity. While some care in wiring and construction is necessary to secure a stable two-stage i.f. amplifier, the result is well worth while. The use of good sized by-pass condensers, as indicated in the plate circuits, is essential. Little difficulty will be experienced with instability if the plate leads are kept short and the layout remains about as shown. The six tuned circuits provided in the i.f. amplifier will provide good selectivity and make it possible to get good separation of stations three or four kilocycles apart.

The band spreading arrangement is such that the amount of band spread can be changed as desired. At W8LFE about four inches per band has proven to be ideal. Not too much to tune across after a CQ, but still enough to hold a signal easily. Ten-kilocycle divisions on the dial are usable and one can easily estimate to within two or three kc. The use of plug-in coils is a practical necessity for any *simple* receiver and not a great disadvantage. The "band setting" condensers are of 100 μμfd. capacity and the band spreading condenser is a 33 μμfd. per section dual. The oscillator band setting condenser should be well shielded and located back of the panel. In that position it can be set and locked to maintain constancy of calibration. The detector band setting condenser is located on the panel where it can be used as a trimmer. To give maximum band spread, the band setting condensers should be set at full capacity and the coils adjusted to resonate on the desired band. To give less band spread, less capacity should be used in the band setting condenser and more turns used on the coils. The coil windings shown in the table have been used and found quite satisfactory. They give good band spread without a change in the



Close-up of the Tuning and Shielded Trimmer Condensers

oscillator band setting condenser for 20, 40, and 80 meter operation.

In the top view of the receiver, the small, shielded, oscillator band-setting condenser will be noted just to the right of the rear tuning condenser section. The front view, figure 3, shows the controls, the tuning dial occupying the most space but all essential controls being conveniently arranged.

The main tuning dial is an important feature of this design. The mechanism is the movement of a fan-type broadcast receiver dial with the celluloid scale removed and a long pointer substituted. A slot in the panel backed up with a cardboard scale provides a dial that may be calibrated directly with the whole band picture before the operator continuously. A good, big, easy-on-the-fingers knob helps complete a dial arrangement that will prove itself in service at any station and not hurt your pocketbook.

Another part of a receiver that should receive first attention even in a simple, easily constructed receiver is an "R" or signal intensity meter. Referring to figure 1 it will be noted that an 0-2 milliampere meter is used (a shunted 0-1 ma. meter in this case). This meter, together with R_{21}, R_{22} and R_{24}, forms a simple bridge circuit that results in the meter reading upwards with an increase in received signal intensity.

This meter, of course, is only in use when the receiver is operating on a.v.c. Incidentally this R-meter circuit may be adapted to any receiver using a.v.c. The 1000 ohm variable resistor adjusts the meter to read zero with no signal input. In the receiver illustrated, it was mounted on the rear of the chassis for screw-driver adjustment. It is only necessary to readjust when changing tubes or after an appreciable shift in plate voltage.

COIL WINDING DATA

Band	*Det. grid*	*Ant.*	*Oscillator*	*Osc. tap*
20 meters	5	4	5½	2 from bottom
40 meters	12½	6	12	4 from bottom
80 meters	24	9	34	8 from bottom

Note: No. 22 d.c.c. wire used. Coil forms five prong, 1¼" diameter. 20 meter coil windings are spaced diameter of wire, all others close wound. All coils will give band coverage with the same adjustment of band setting condenser.

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Primary Keying Notes

By Harry G. Burnett, W1LZ

In regards to the system of primary keying outlined by the writer in "Clean Primary Keying and a P.D.C. Note", (p. 46, March, 1937, Radio), there is always the danger of accidental shocks from the final filter, which remains charged with this method of keying. If one is unwilling to depend entirely upon the bleeder or remembering to short the final power supply before experimenting with it or the final amplifier, there is a simple means of reducing the hazard. If the primaries of the oscillator and grid-bias power packs are connected in parallel, it will be found that when these packs are switched off simultaneously the final filter will discharge almost all of its energy. This will cause a very short "tail" to be emitted when the transmitter is shut off, but it may be worth while to put up with this to gain the added protection. Following this same line of reasoning, some amateurs, when keying in the center tap, press the key to discharge the filter after shutting off the plate switch. The load resistance presented by the bleeder is not sufficiently low to discharge the filter immediately.

It is surprising to note how little the "blinking" of the lights is augmented by keying the buffer transformer along with the final transformer. It may be found desirable, however, to lessen this "ducking" of the lights by connecting a 30 or 40 watt lamp across the key (smaller for lower power). This resistance will serve to energize the cores of the transformers a bit when the key is open. When employed with straight primary keying this resistance would pass enough power to the buffer and final tubes to introduce a back wave. With the system previously described, no effect upon the transmitter signal will be noticed, because of the grid-blocking effect of the bias pack, unless a larger lamp (100 watts or so) is used across the key. A decided reduction in thumping of the transformers and lessened sparking at the key will be gained by using this resistance.

This sparking at the key can be reduced further by connecting a one or two μfd. condenser across the key. Using such a condenser, a "signal" standard wireless key with 3/8 inch contacts handles the job with ease at W1LZ. An ordinary telegraph key with Ford auto radio vibrator contacts substituted for the original contacts is used with this keying system at W1CO and works perfectly. There should be no necessity for resorting to a relay, unless one desires to use a "bug". The Ford contacts (tungsten) should make good contacts for such a relay. Whether a relay or key is used, it will be wise to keep the contact spacing as large as possible to prevent needless sparking and sticking.

An a.c. line filter, composed of two heavy r.f. chokes in series with the line and two 2 μfd. condensers in series connected across the line with their center tap grounded, plus the condenser across the key eliminated clicks in neighboring b.c.l. receivers. It will pay to try connecting the condensers both across the line on the set side and on the power side of the r.f chokes. They performed far better on the line side in our case, as evidenced by listening to a b.c. set in the same room with the transmitter.

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Signs of the Times

Listening to the boys on the air is quite enlightening, and at times amazing. For a few hours the other day we tuned over the bands to pass the time while recovering from the "flu".

There was a phone in Pennsylvania telling another in Ohio about being unable to hear any "sidebands" outside of the sharp phone carrier, and suggesting a higher level of modulation. It seems that if the "sidebands" aren't present, the modulation percentage must be down around 70%. We had to stretch our definition of "sidebands" somewhat to understand the statement and we decided that the chap never worked in a broadcast station.

Then there was the fellow who left his 14 Mc. phone carrier on the air while answering the telephone. A number completely neglected to mention their call at the end of each transmission; a three-way was handled by signing "W5- and W9- by for W9-" making it impossible to decide which station was using whose call; and several gave the call of the station worked after their own call on signing, adding various addenda. F.C.C. rule 384 reads in part, "An operator of an amateur station shall transmit its assigned call . . . at the *end* (italics ours) of each transmission."

One phone called CQ for "any phone or c.w. station on the twenty meter band." We wonder if he really listened to each code and phone signal over the whole 400 kc. to find out who was calling. What would the chance have been for a code station on 14.0 or 14.4 Mc. to have raised him even with a two minute call—without having some idea as to how the phone operator was going to tune his receiver.

And a fellow in Massachusetts had a message for Connecticut, trying to raise a W8 on twenty meters to handle it. Why not try 80 or 160, or mail it?

All this time a fine W4 station was working "Pearl", our only point in mentioning it being that a few hours is long enough to handle all that gossip—even on code.

Things were different on 28 Mc. Instead of much talk about bad QRM from phones, "making a QSO impossible", as many clear signals were pounding through as on the whole 14 Mc. band. A W6 was having a fine rag-chew on phone with someone, and it turned out to be with a ZS in South Africa. Another W6 pointed out that while "10" recently closed down at six o'clock, it opened again two hours later for W contacts and still later the Aussies came through fine.

One or two signals were subject to selective fading which made them overmodulate badly and distort when the carrier fell out. A VK suggested a lower modulation percentage when that happens—the signal is usually strong enough, anyway.

QRM was so absent that the whole 14 Mc. phone band could sometimes be dropped between adjacent ten-meter phones without scratching the sidebands off either. Only one complaint of QRM was overheard and that was because a code station landed on a phone—the phone complaining. —*W9FM.*

◆

These newspaper stories that describe ham radio for those on the outside grow more and more of a wow. One in the Kansas City Star has a ham asking a clerk for a 5-15 condensing tube. "Whataya want, CD or Mallory?" replies the clerk, himself a "ham".—*W9KNQ.*

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Doctors have waged a fight for several decades to get the moon out of medicine. Radio hams might now take up the fight, what with the growing talk about dx on the full moon!

Multi-wire Lines and Matching Sections

By Carl J. Madsen,* W1ZB

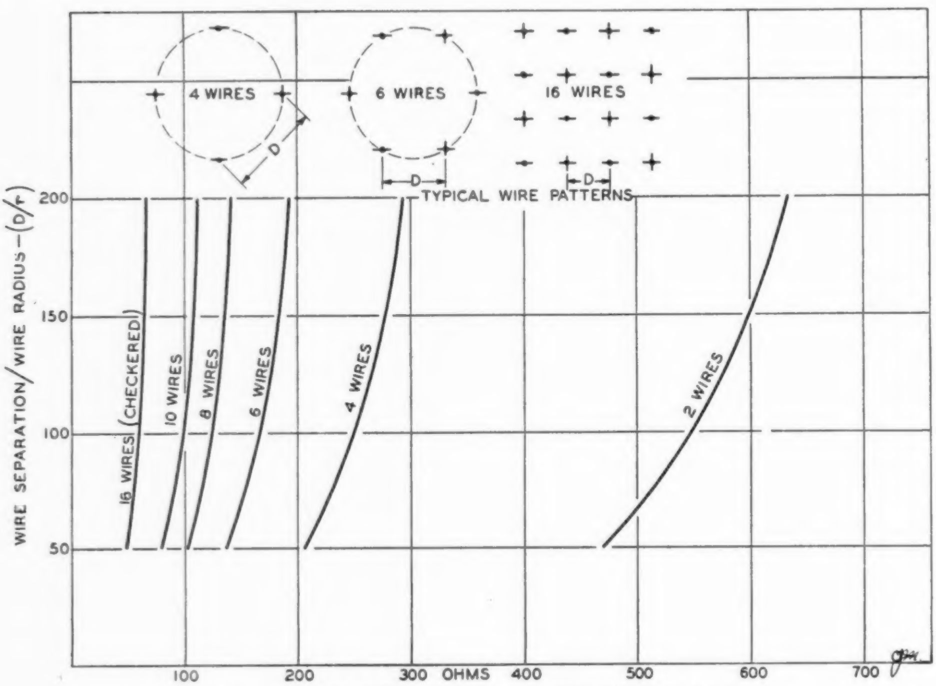

FIG. 1 SURGE IMPEDANCE OF M.C. TRANSMISSION LINE

WESTINGHOUSE ELECTRIC & MFG. CO

Many of our amateur antenna systems and coupling circuits require radio frequency transmission lines, either as impedance matching transformers or as a connecting medium between the transmitter and antenna system or both.

During a problem of the latter type, I found that I needed a line some thirty odd feet long with a surge impedance of 200 ohms. Checking all the usual two-wire transmission line constants I found that I needed two 1/4 inch tubes separated by approximately an inch. Trying to hang a line of this type from the middle of a 66 ft. span of wire 45 feet in the air didn't appear to be very practical physically. A concentric tubing line was equally impractical. Smaller size conductor could have been used with closer spacing but the voltages involved dictated a design with at least one inch between conductors, especially for outdoor operation.

After considerable investigation through old issues of *QST* and Radio, no additional information was uncovered which might be available to amateurs. I did find the curves shown in figure 1 in technical data files of the W. E. & M. Co. The 200 ohm line problem then became very simple. A four-wire line using no. 16 wire (.060 dia.) figures out to have a separation of 1.5 inches (.03 x 50). Using 2 1/4 inch dia. celluloid rings (obtained in the 5 & 10c store) and drilling four holes slightly larger than the wire equidistant around the ring, a light spacer of low loss is obtained suitable for amateur application (see page 49—Radio, Jan., 1937 for two-wire line). These can be threaded on the line, placing them on the wires near the ends and then stretching the wires tight and sliding the spacers to the desired position. They can be cemented in place with DuPont household cement. At least two applications and preferably three, separated by several hours, will hold the wires nicely.

Such a transmission line is flexible and must be used under slight tension to keep the wires

*Radio Engineer, Westinghouse Electric & Manufacturing Co., Chicopee Falls, Mass.

from twisting. Spacers should be placed approximately every two feet. The conductors of like polarity are connected together at the ends of the line, making it easy to connect to the antenna system or the usual 400-600 ohm transmission line as in the "Johnson-Q" system. The 4-wire line takes the place of the "Q bars", making a lighter matching section.

The chart in figure 1 gives the surge impedance for several other groupings, giving lower impedances than the two- or four-wire combinations. "D" is the separation of conductors, "R" is the wire radius. The construction of these multiwire combinations becomes increasingly difficult as the number of wires is increased; so unless you have lots of patience and mechanical skill, it is advisable to use the simple grouping combinations of six or less conductors.

This type of line can be used in the Collins "Multi-band" antenna system, or any application where a low-impedance line is required, at considerably lower cost and with less radiation loss.

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Postscripts and Announcements

Flat-Top Beam

In the Kraus "flat-top" beam shown last month, there was one point that might be confusing. In figure 1-A, the wire passes *through one eye* of insulator 2, there being no break in the wire. This is obvious from the other diagrams, but because of the position of the insulator "2" in figure 1-A, it appears as though there might be a break.

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Stamp Collector Hams

We have been asked to run a list of calls of hams throughout the world who are stamp collectors. Send in your calls and the calls of any philatelic hams who are known to you, and we'll be glad to print the list.

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Regarding the use of the Super Gainer as a monitor: placing a switch in lead between the end of the coil of the first detector and ground and by-passing it with a condenser serves the same purpose and is more convenient. No repeats will be discovered within the amateur bands, but that there is another beat at a considerably higher frequency. For instance, when working on 40 meters, one can get a signal through in the vicinity of 25 meters.

—*W2JKT.*

Oddity Contest

For the most unusual radio experience, submitted with proof, or for the most unusual photograph of odd radio equipment which really works, RADIO will present the winning entrant with a pair of T-20 transmitting tubes.

The facts submitted must not have appeared as "radioddities" in any other paper or magazine, nor in any "Believe-It-or-Not" cartoon, but may be based on bona fide news articles.

Any fact must be accompanied with proof, which of course will vary in requirement with the circumstances. A news article or reference to a standard textbook might suffice in one case; in another an affidavit might be made, or signatures of well-known, qualified observers might be appended.

All entries must be mailed to the Contest Editor, RADIO, before April 25.

That Expiration Date

A number of inquiries have been received as to the issues with which subscriptions expire. The last issue which will be sent on each subscription is indicated on the address stencil of subscriptions received since July 1, 1936. The last three figures of the "key number" under your address indicate the *number* (not date) of the last issue which you will receive. The number of each issue is indicated on the outside bound margin and on the Contents page; this issue is no. 218; there are ten (not twelve) issues per year.

◆

Contests

The world-wide interest in contests has grown to the point where some place of registration might be established in an attempt to avoid overlapping schedules. With the VK-ZL dx test occupying five week-ends—10% of the year—and several others doing the same, it is obvious that conflicts will occur. The proper organization to take care of this seems to be the I.A.R.U.

Incidentally, how long should a contest be? If it runs consecutively for about ten days without a time limit, physical exhaustion of the operator is a factor which must not be overlooked. We have heard of fellows getting only thirty hours sleep in the whole A.R.R.L. contest. This difficulty is cured by using only week ends; but five in a row means possible divorce, or giving a tremendous advantage to other aspirants for the girl friend's favor.

DX

By HERB. BECKER, W6QD

Readers are invited to send monthly contributions for publication in these columns direct to Mr. Becker, 1117 West 45th Street, Los Angeles, California.

Here we are right in the middle of the dx contest and what a battle it is. The competition is keener than ever and the boys have this one really figured out, such as complete rigs on different bands, two receivers, etc. Dx on all bands has been especially good with the possible exception of 40 meters. The countries and multipliers will run much higher than last year, and I for one am anxious to find out just how high they will go. Even now with the test a few days to go, I know of dozens of fellows whose multipliers are well over 100. There has been a lot of good new dx worked and many new tricks have been uncovered. The 10 meter band has been exceptionally hot, and 20 has been just as good . . . but 40 seems to have given up slightly to the other two bands. 80 is doing the boys a lot of good, too. Of course this is all written from the western viewpoint, and as a matter of fact I don't know why I'm tellin' you all this, because you probably have been on and know more about it than I do. The contest news that this department has at present will be held over until the next issue, in which more detail will be given.

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W7BB takes issue with last month's crack about the Washington kw., but appreciates the plug given the firm for which he works . . . so I guess that evens things up. He starts out his letter . . . "The March issue of RADIO has just been handed to me . . ." Gosh, he really gets service from someone, anyway.

ZL2NN has finally hooked a couple of Africans for his w.a.c. Africa is the "sticker" for ZL. FT4AC and FA8DA are the ones. He has 25 zones and 39 countries. Says he should be eligible for the 210 club as he uses 100 watts on a pair of 'em.

The photograph of Ginger Rogers sent G2PL must be rather well guarded as a few of the G's have written saying that 2PL won't let anyone see it . . . G6HB is the last to complain. Come on, Pete, open up and give the boys a break.

SM6WL, who writes a dx column for a Swedish radio magazine "*QTC*", says that a number of the boys are consistently active . . . SM6UJ, SM5UU, and SM7UC. The setup at SM6WL is a 6L6G C.O. and doubler, and two RK20's in the final with 140 watts input. Receiver is a super gainer with metal tubes. His antenna is 132 feet long with 33 foot feeder and Collins coupler.

They're at it again. . . . G5YH takes another crack at the K6 gang. Says he has called K6AKP, JPD, MVY, BNR, ESU, many times but ND. Said he heard BNR telling a VK . . . "Didn't seem to be able to hear the Europeans." Hope you boys will stay under control. Anyway, the frequencies of 5YH are about 14,320 and 14,090 kc.

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From W8JK comes the word that the new prefix for the Belgian Congo is OQ. ON4CGW (now OQ5AA) has been coming through well on 20 meter phone and his frequency is 14,066 kc. This station is owned by Dr. George W. Westcott and his QRA is *Tondo via Irebu, Belgian Congo*. The doctor uses a pair of tens in the final with 70 watts input and has a folded Bruce-type beam quite similar to the one that W8JK uses. Dr. Westcott is doing some really fine work at the hospital where he is located, but his home is in Ypsilanti, Michigan.

Some of you fellows will remember that phone station who was signing NX2Z last year. From 8JK as well as from other boys we learn that this station was not genuine, as when Ole Winstedt (the real NX2Z) returned to Copenhagen he was amazed to find hundreds of QSL cards waiting for him, with reports of his 20 meter phone QSO's. He has never been on 20, and never on phone. Anyway, here is a copy of the letter he has been sending out in explanation of the above . . . copied "word for word":

Dear OM:

Arrived from Greenland last September. I am very sorry to tell you that you have not heard my NX2Z; you have heard a false station and I will be very glad if you can tell me a little about him. I have got many cards from W and VE and now I know the operator's name is "Jerry Reed", and the station works with 1450 watts, but I don't know his QRA. I do not think it could be a station in East Greenland. There are three: OX7XL, OX7ESK, and NX2Z, and none of them has 1450 watts, and now we are all in Denmark. OX7ESK is the only station on phone. I have cards from W amateurs for QSO's in December '35 and January '36 and at that time I was visiting OX7ESK and then we had no phone QSO's.

After this long introduction I will tell you a little about my life the last two years. In July, 1934, we left Copenhagen and arrived in August at Hochstetter Foreland near 75°08′ north and 19°55′ west. There were six men taking foxes and icebears and I was wireless operator, too. Hochstetter Foreland is a "town" but there is only one house. Along the coast we have cabins at intervals of about 15 miles. In the winter we drive dogsleds between the station and cabins and are not at any place more than one or two nights.

In May, 1935, I left Hochstetter with a companion for a trip to Hvalrosodden (Walrus Point), a tongue of land near 77° north 20° west. Here we were for the summer from May to October and left the station as soon as the ice was again good for driving. It was the intention that we should stay here in the winter 35-36 but the ship could not reach the coast with new provisions so we must go south again to the stations for more food. The ordinary schedule is for one ship a year.

In November '35 I got the mail that the ship had dropped with OX7ESK by airplane in September. From September '35 to May '36 I have gone 1185 miles by dog sledge so you can see that I have not been on the air much.

My station at Hochstetter was only 15 watts but had many good QSO's with Europe, mostly Scandinavian, G, D, and all on 7 Mc. Hvalosodden had 100 watts and was also fine with Europe but I

never worked a W or VE station at those two stations. In 1932-33 I was in Thule on the northwest coast and a few W stations were heard by me but I am sorry that I could not get QSO. In the winter I think I will get my station ready but only with 10-20 watts. I am a QRP man and the call is OZ2Z.

Now no more this time but if you know something about the false NX2Z please write to me again.

O. WINSTEDT.

W7AMX built himself one of these "Conversion Exciters" such as was written up by W6BC in RADIO for last June. Incidentally, fellows, there is something worth looking into. In the story it may have looked a little complicated but when you get it built you have a crystal note on any frequency in the band you wish. Uses one crystal and by twisting a couple of knobs you land any place in the band that suits you . . . Now doesn't that sound good? Look it up . . . It's got electron-coupled oscillators beat for stability —can't be told from crystal. Anyway, W7AMX is up to 37 zones by hooking YR5AR, 14,425 kc., making him 93 countries.

Johnny Kraus, W8JK, has worked a bunch of PK's on two-way phone . . . PK1JR, PK1BX, PK1MX, PK1QU, PK1VM, PK1DB, PK3ST; also KA1ME, KA1BH, KA1JR, and J2LL. FA8JO and OQ5AA (ex-ON4CGW) are other recent ones. John uses the flat-top beam such as he described in last month's RADIO and since he installed it he has had good two-way contacts with VU2CQ and SU8MA and one-way with U9AW in Siberia. He has 34 zones on c.w. and 24 on phone.

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Ned Jacoby, W8KPB, is operating W1ET while attending Dartmouth and has been doing some good dx. I had always thought that when a guy went to Dartmouth he never had time to mess around with dx. In one month from their station they have worked 51 countries and 25 zones . . . this is all from scratch.

W2HVM uses 200 watts into an O3A on 14 Mc. and has done quite good work . . . U3QE, ZU1C, ZT5Z, ZT6Q, ZS1AN, ZS1AH, CN8MQ, SV1KE, TF5C, FB8AB, HAF8C, UN2A (EL2A), OH3NP, OH1NL, OH5OA, FM8F, CP1ANE, and CX1BU . . . VP1WB, VP5JB, HC2CG, OA4AQ, and VP7NI. W2HVM remarks, ". . . as for Calif. kw.'s and resonant filter, my feelings are those of most decent east coast hams." Ahem!

W9KA comes to the rescue and gives the info on how to get a card to VE5NO. Address all cards to District Superintendent of Radio, Box 310, Halifax, Nova Scotia, Canada. W9KA tried to get a card to him and it came back with 16 different Canadian postmarks on it, so let's thank Roy for this dope. May give us a way to get up into zone 2.

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Now VE4KZ shoots in the lowdown on how a card will find VE5LD . . . also in zone 2. Address: VE5LD, D. G. Sturrock, Hudson Bay Co., King William Island Coppermine, N.W.T., c/o Fur Trade Dept., Winnipeg, Canada. VE4KZ says VE5LD uses a pair of 31's and 10 watts input . . . 14,020 kc. . . . And now another VE heard from, this time VE2EE, Stan Comach. He is on phone and c.w. and has worked K4KD and EA4AO on four bands. 2EE has 26 zones on phone and 32 on c.w. I wonder if any of the Canucks can tie that? If I remember right, Stan holds the first phone w.a.c. in Canada.

[*Continued on Page 74*]

"WAZ" HONOR ROLL

ON4AU	40	G6QX	33
W8BTI	39	W9AFN	33
W7BB	39	W9ALV	33
G2ZQ	39	G6CL	33
W3SI	39	W6VB	33
W6CXW	39	W6BAM	32
W4DHZ	39	W6KIP	32
W8CRA	39	W8AAT	32
W6GRL	39	W8BTK	32
W6ADP	39	W5EHM	32
W3PC	39	W9EF	32
W3ANH	39	W6NHC	32
W9TJ	38	VE2EE	32
G5YH	38	W2AAL	31
G6WY	38	W6FL	31
W6CUH	38	W3DCG	31
W6QD	37	W5CUJ	31
W8BKP	37	W3EXB	31
W2GWE	37	W3EVW	31
W8OSL	37	W6KWA	30
W6FZY	37	W4MR	30
G6NJ	37	G6GH	30
W2DTB	37	W8DED	30
LY1J	37	W3CIC	30
W8HWE	37	W6GHU	30
W8LEC	37	W9IWE	30
W6HX	37	W6FKZ	30
W7AMX	37	W8OQF	30
W8KPB	36	W6DIO	30
W8KKG	36	W1APU	30
G6RB	36	W3AWH	29
W8DFH	36	W9LW	29
W9ARL	36	W6HJT	29
W1ZB	36	W8FJN	29
W1CC	36	G6ZU	28
W9PTC	36	W3TR	28
W6GAL	36	W8DOD	28
W6AM	36	ZU1T	28
W9KG	36	W6CGQ	28
W2HHF	36	W6GNZ	28
W3EDP	36	W5EOW	28
W2BSR	36	W9JNB	28
W6GRX	35	W6HJT	28
W8CJJ	35	W3EYS	28
W2AIW	35	W6CEM	28
W6EGH	35	W6JBO	28
W2BJ	35	W9VBB	28
W3BBB	35	W6GK	28
W9EF	35	W3CDG	28
ZG1Z	35		
W9KA	34	**Phone:**	
W8JK	34	W5BDB	27
W3EMM	34	VE2EE	26
W2BJ	34	W3SI	25
W8LEC	34	W8JK	24
W3EJO	34	W3EMM	24
W2FAR	34	W6ITH	24
W9PK	34	W6AM	23
W9LBB	33	VE5OT	23
W5AFX	33	W6LLQ	22

If you have worked 28 or more zones and are willing to produce confirmation on demand, send in your score on a postcard.

Phone stations need work but 20 zones, but stations must be raised on phone. Stations worked may be either c.w. or phone.

Applying the Multi-wire Line to the "Q" Antenna

There are many cases where a ¼ wave low impedance matching section of the type used in the Q antenna (½" aluminum tubes spaced 1.5" or so) would be much too heavy to be supported from the center of an antenna. In cases of this type, the multi-wire line as described by Madsen elsewhere in this issue becomes a very useful solution to the problem. This type of line is much lighter, fairly easy to construct, and much less expensive than the aluminum tubing line. This type of line does, however, have the disadvantage that it cannot be readjusted once installed. It must be calculated to meet the antenna and feeder conditions with which it is to be used. However, if these computations are accurately made and the line constructed as closely as possible to the calculated dimensions, no readjustment will be required.

The "Radio" Antenna Handbook has a number of tables that are very useful in determining the lengths, impedances, etc., that are needed to figure a complete antenna system. Assuming that the antenna is resonant at the operating frequency, there are two values that must be known to calculate the impedance of the ¼ wave matching section (the "Q" bar impedance in the "Q" system). These are the impedance of the antenna at the point where it is being fed and the impedance of the transmission line.

Since it is a very difficult problem to feed an antenna with this system at any point except the center, the assumption will be made that in every case the antenna is being fed at this point. The center impedance of a ½ wave length antenna varies quite widely when it is suspended at distances from 0.2 to 0.6 wave above ground. However, at both 0.25 and 0.5 wave length above, its impedance is very near to 75 ohms. So if the antenna is suspended at either one or the other of these heights we can be fairly sure of its impedance and make the balance of the calculations accordingly. It so happens, however, due to a characteristic of the quarter-wave-line matched antenna, that if we take our ½ wave center impedance as 75 ohms and design our matching section to match this impedance accurately to our transmission line surge impedance, we will very seldom experience any trouble with standing waves on the transmission line.

The center impedance of a 3/2 wave antenna can be taken as 100 ohms, 5/2 wave as 115 ohms, and 7/2 wave as 125 ohms for calculation of the ¼ wave section.

Knowing the center impedance of the antenna and the impedance of the transmission line to which it must be matched, the characteristic impedance of the ¼ wave matching section can be calculated by the following formula:

$$Z_s = \sqrt{Z_a Z_1}$$

where Z_s is the impedance of the matching section, Z_a is the radiation resistance of the antenna, and Z_1 is the surge impedance of the transmission line between the transmitter and the matching section.

Then as soon as the impedance of the matching section has been computed, upon refering to the chart indicating four wire line impedances on page 66, the ratio of the spacing to the diameter of the wire used in the section can be found.

For a practical example to help clear any doubts that may exist as to the proper procedure in figuring, let us take the following. We want a ½ wave 14 Mc. antenna suspended ½ wavelength above ground and want to know the proper design of the complete system from the transmitter to the flat-top. The actual frequency on which we are to operate is 14,200 kc. or 14.2 Mc. Dividing this into 468 we obtain the flat-top length as 32.95 feet or 32' 11". The matching section is exactly half this long or 16' 6". A convenient transmission line from the rig to the bottom of the matching section would be of No. 12 wire spaced on 4" spreaders. This line would have a surge impedance of about 550 ohms. To match properly this impedance to the 75 ohm impedance at the center of the antenna would require a matching section of about 200 ohms characteristic impedance. This can be obtained (by reference to the chart mentioned before) by means of four wires spaced equidistantly around a circle at a spacing of 50 times the radius of the wire used. If we use no. 14 wire with a radius of about 0.03" we will have the same case as mentioned by Madsen. The spacing between wires will be 1.5" and the diameter of the circle in which the wires are mounted will be $\sqrt{2}$ or 1.4 times this or 2.1".

The wires could well be separated by a series of 2¼" dia. celluloid rings as Mr. Madsen suggests.

In case the antenna is of a different length than ½ wave or if a different transmission line impedance is used, the impedance of the matching section will be different than 200 ohms. In this case a reference to the chart will indicate the new ratio of spacing to wire radius.

Another case where this type of feeder could be used as a matching section is in the "Collins Multi-band" antenna system. The characteristic impedance of the line used in this system should always be 300 ohms. This impedance can be obtained, by reference to the table, in a four wire line with the wires spaced 210 times the radius of the wire used. Since the circulating current in this type of feeder is not particularly high and since this current is divided between four wires instead of the usual two, no. 18 wire can be used on any power up to one kw. without danger of excessive losses or overheating. With no. 18 wire (radius 0.02") the spacing between conductors will be 4.2". The spacers in this case can be 6" embroidering rings obtained from the 5 & 10c store.

Care must be taken to connect the various wires of the matching section according to polarity as shown in the chart given with Madsen's article.

Can QRM be Reduced?

By E. H. Conklin, W9FM

Often we ask ourselves if anything can be done about the increasing amount of interference in our bands. If some steps can be taken, what are they, and should they be proposed now or when the situation becomes even worse?

In densely populated places a most disturbing type of QRM is encountered—that of a local station opening up on top of the one being worked, or causing key clicks or phone hash from a somewhat removed frequency. Aside from the keying surges and splattering modulation, which should be cured at the source, improvement may be had through the use of a receiving antenna which picks up horizontally polarized waves practically to the exclusion of the vertical component. Try a half wavelength horizontal wire cut for the lowest frequency band normally used, with a tuned two wire spaced—or transposed—feeder. The antenna coil midpoint can be grounded, and a Faraday screen used, to eliminate possible operation as a T antenna against ground by capacity coupling. By avoiding twisted pair, a reasonably good all-band antenna is obtained

—which requires no retuning unless used at a lower frequency than the band for which it was cut. Not only will ignition noises and the neighbor's oil burner come through much weaker, but local transmitters will have a lower strength compared with the distant signals.

It is probably nice to chat with a fellow across town on a dx band when both are using the dx band most of the time, but it just isn't fair to the rest of us. Some of the boys can't change bands in five seconds—or even five minutes—and howl at the suggestion that transmitters should be built for flexibility, but those should at least arrange to hook the antenna on the 80 meter crystal stage for working locally. It has been long since we have heard anyone suggest that both stations shift to another band more suitable for the distance involved.

The dx contests have done much to make transmitters more flexible—note, for instance, the absence of VK and ZL stations on 7 Mc. now that so many of them have rebuilt to make 14 Mc. available. Here again the only solution may be the establishment of a code whereby one shouldn't call or work anyone not at the best distance for that band and time of day, and certainly no one within the ground wave length on a dx band, except to establish contact to arrange for continuing the QSO on a more satisfactory frequency. Within the ground wave range, a separate transmitter using a 50c tube, or the crystal stage of the regular rig alone, should be sufficient.

Then, too, there is the power question. Many dx stations work us with a pair of 46's, putting in a good signal. Others insist on using at least a half kilowatt at all times. Some use full power to work stations as close as 1000—or 10—miles. In a sweepstakes contest a while back, it was felt that the "low power multiplier" for using 25 watts or less favored low power. We ran up a very nice score without staying home from work or losing sleep. We raised as many as ten stations an hour by carefully selecting the frequencies used, though a few selections over 2000 miles away had to be raised on 7 Mc. in the midst of the evening "mess." We even worked the west coast on 80 meters. That was before every audible signal was called "R9," yet we received R6 to R8 reports at 1000 miles. The idea of mentioning all this is to attempt to drive home the point that 25 watts should be enough for working anyone 1000 miles away. Here again we don't advocate a new law to limit power. We could probably get along on 25 watts for the first 1000 miles and double that for each additional 1000 miles—which figures 800 watts for 6000 miles and above, but more power may be necessary during summer static periods on the lower frequency bands. We should frown upon the

[*Continued on Page 79*]

Dx News

[*Continued from Page 69*]

I am glad the VE's are coming to life and sending in some dx news; those boys have been doing great work up there, but for some reason or another they are a little modest. So break down now and let's have a big VE section every month.

The contest now has but a few hours yet to go and here I am in one room grinding this out while the Ed. is in another crabbing because I'm so slow. Anyway, this department *hoped* to announce the first score of the dx contest for 1937 . . . Oh yes, QD in the limelight finishes the contest in a blaze of glory or something . . . with a score of 759 points. Yessir, a multiplier of 11 is not to be sneezed at . . . and my friends, this was done without the aid of a single W9. Unless I boost my power a couple of watts and snag a K6 in the waning moments, my score will go in as 759 . . . One band, one operator, one antenna, one hour per day, and that's my story. I would sure like to print some scores that I happen to know at present, but no, you'll just have to wait until next month. However, here's something to think about while you're reading the evening paper: The high point man on the East coast will have over 125,000 points and the high man on the West coast will have over 100,000, while in the middle West the points will run somewhat under this. Remember, this is only a prediction; so don't lay any money on it. My score won't be the lowest W6 because I think CUH has 6 points.

•

One thing more. All of you fellows who have just worked a few stations in the contest, please don't think you shouldn't send in your score . . . It is very important that you do. So in signing off, all of you dxers send in your contest log, no matter how small it may be. Send it to A.R.R.L. . . . *not* to me.

We made the department small this month so we could splurge next month. Besides, I was too busy rolling up my 759 points to write any more anyhow.

◆

The "J" Antenna

[*Continued from Page 43*]

be used in the line to remove d.c. from the line. Mica condensers of about .002 μfd. will usually be satisfactory.

Continue to readjust the point where the line taps on the quarter-wave matching stub until minimum d.c. plate current in the final amplifier occurs at the same point on the plate tank tuning whether the line is connected to the tank or not. Of course the d.c. plate current will be *greater* when the line is coupled to the plate tank, but that is to be expected and the amount of current in either case is not important, except that it should be low enough so that the tubes are not damaged.

In most cases, where the radiating portion of the antenna is a half wavelength long, the transmission line tap on the stub will be found between 20% and 33% of the way up the stub from point B in figure 1. As the length of the radiator increases, the transmission line tap will move up the stub. Also a low-impedance line will tap on the stub closer to point B than will a high-impedance line. When the charac-

teristic impedance of the transmission line is less than 100 ohms, special treatment of the stub is usually necessary. The common type J antenna system works best with lines of from 300 to 750 ohms characteristic impedance. (For example, a line consisting of no. 12 wire spaced 6 inches has a characteristic impedance of 600 ohms.)

Adjusting the Coupling Between the Line and the Transmitter

This is the last step and the simplest of the three steps. However, never start to think about adjusting this coupling for optimum results until the other two steps have been completed. The antenna must be operating at resonance and the line must be free from standing waves.

Starting with loose coupling between transmitter and line, increase the coupling until one of two things happens. Either t he plate loss on the final amplifier tubes exceeds rating, or the d.c. plate current drawn by the final amplifier, in resonance, reaches a safe maximum. These are independent limits and whichever one is reached first determines maximum permissible load coupling.

If an r.f. ammeter is placed in series with the transmission line, maximum current in the line should occur at the same tank condenser setting as minimum d.c. plate current. If this is not the case, it is likely that there is too much L and

not enough C in the final plate tank circuit. Cut a few turns off the plate tank coil and add some tuning capacitance to rectify this trouble. Any change in the plate tank inductance will necessitate a readjustment of the coupling between the tank and the transmission line.

Special Types of Antenna Systems Using Closed Stub Impedance Matching

The fundamental stub-matched antenna system is the system described thus far, where the length of the radiating portion of the antenna is a half wavelength. The length of the radiating portion of the antenna can be any multiple of a half wavelength (electrically) up to about 6 full waves long without any changes except in the position of the line taps on the matching stub. When the length of the radiator exceeds about 6 full waves it is often desirable to use the arrangement shown in figure 2, with the radiator not connected to the end of the matching stub (point C in figures 1 and 2) but to a point intermediate between C and Y where the line taps on. Under certain conditions where the radiator length is very long, the points Y and Z (figure 2) coincide.

This expedient of tapping the antenna down on the stub has no effect upon the tuning procedure except that the first step is to tap arbitrarily the radiator down the stub a convenient distance. The whole purpose of tapping the radiator down on the stub is to raise the Q of the stub in order to keep unbalance out of the transmission line and allow equal current in each side of the line.

However, very long wire antennas are not used very much, as most amateurs would be inclined to install a V or a diamond array if that much wire and room were available.

The radiator can be either horizontal or vertical, and the stub also can be at any convenient angle with the horizon, or with the radiator, as can the line.

The Stub-Matched T Antenna Systems

Figure 3 shows the common type of stub-matched-impedance antenna system using a *closed* stub while figure 4 shows the same system using an *open* end stub. In both cases the stub length is a quarter wavelength. The arrangement of figure 3 is used when the total radiator length (flat top) is such that the stub attaches to high voltage points in the radiator. Thus an even number of quarter wavelengths of radiator on *each* side of the stub would allow this arrangement to be used. In general, for best results, the stub should be either in the center of the radiator or at one end, although it is possible to get fairly good results with an unequal number of half waves each side of the stub.

The arrangement shown in figure 3 is tuned exactly like the J matched system. When the stub feeds power to the antenna at a low voltage, or high current point, the open-end quarter-wave stub, as shown in figure 4, must be used. This arrangement differs from all those shown before in that there is high voltage at the bottom of the stub (points A and C in figure 4) while there is low voltage and high current at the upper end (point B in figure 4). The open-end stub arrangement is fed by the transmission line as before, but the distance M from the high current point B now is meas-

ured down from the radiator instead of up from the lower end of the stub. The only difficulty involved in the open stub arrangement is that it is hard to establish resonance in the antenna and stub system. The system is tuned by pruning the open ends of the stub, a little at a time, while reading for maximum current at point P. Naturally, it is impossible to find the adjustment for maximum current until after passing it, at which time it becomes necessary to "unprune" an inch or so of stub length. This is easier said than done, as soldering on a couple of short pieces of wire at A and C sometimes causes a really startling corona loss, especially when using rather high power. It is hard to see just why this should be so, but evidently the soldered joint so close to the point of maximum r.f. voltage increases the potential gradient through the air at that point, which aids a corona discharge.

An understanding of the adjustment procedure and theory of operation of the stub-matched antenna systems will help amateurs to build more effective zepp. antenna systems, for one thing. Also, stub matching and phasing sections are necessary parts of many useful ultra-high frequency directive arrays.

If the stub section will be regarded as a tuned circuit on which various lines and loads are tapped, the autotransformer action of resonant stubs will be materially simplified.

28 and 56 Mc.

[*Continued from Page 27*]

ment from Europeans, who, apart from weekends, are naturally seldom active in large numbers in the early mornings, when Asiatic signals should be coming through.

Apparently the chance of double points in the S.A.R.R.L. Contest at the weekends did not induce many new African stations to try 28 Mc., and those signals which came through were usually weak. ZS6AJ was one of the most consistent, and others heard were ZT6AY, ZU6P, ZE1JJ, ZE1JU, ZE1JR, and FB8AB. CN8MQ reported on January 24 that conditions had been poor on the previous few days, but that he was hearing W's regularly from approximately 13.00 to 17.00 G.m.t., and also numerous Europeans, though the latter usually had low signal strength. He heard a few VK's and ZL's early in the month, but none later on.

The one continent, (apart from Europe), where both phone and c.w. activity are still at a very high level is North America, and signals from all W districts, and VE 1, 2, and 3 were heard during the month, though there was a scarcity of W6 and 7. Those heard well included W6HB, W6JN, W6FVJ, and W7GBI. From the West Indies HI7G and FM8AA have been heard again this month, and a new signal, heard by G6DH, is that of VP9G. FM8AA has been keeping daily schedules with French stations, and has also worked G6WN.

Exceptionally short skip distance for this time of year has enabled many Europeans to be audible in England, and countries heard include EI, PA, F, D, OK, HAF, YT, YR, YM, SP, YL, SM, OH, and U. This is a considerable increase over January of last year, when signals from Western and Central Europe were much rarer.

British activity seems to have fallen off slightly, but a number of new calls have been heard. G6YR, who started up on Christmas Day, and has since worked W1, 2, 3, 4, 5, 6, 8, 9, VE2, 3, ZE, CN, and Europe, voices the general opinion of newcomers to the band when he reports that "after the 14 Mc. scramble, it's a delight to get up onto 28 Mc. for a change!"

[Because on the majority of days the 10 meter band is now as "live" as the 20 meter band, this department will no longer be continued as such. As its usefulness obviously has ended, the information that ordinarily would be contained in this department henceforth will appear in the regular dx section.

If sufficient interest at any time should warrant it, a special 56 Mc. department will be started.—EDITOR.]

Amateur Radiophone W6ABF

[*Continued from Page 29*]

in the accompanying illustration of the r.f. section in order to show the interior construction.

"If I were a postman," explains Brownie, "I would take a walk after work. But working for a radio store, I play with amateur radio instead."

Open Forum

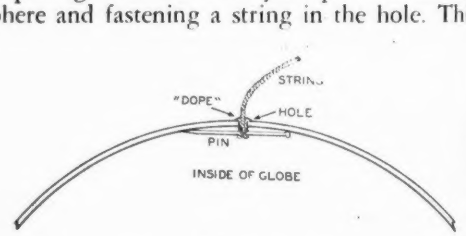
[*Continued from Page 78*]

short wave. The b.c.l. may stand for phone QRM, but I doubt if he will react the same way to those peep-peeps and clicks of a c.w. rig. But then, H.S.P. has been a ham for a long while and perhaps he may be right and I may be wrong.

FRANCIS BROWN.

More Useful Globes

A cheap "globe" can be made more useful by poking a hole in it at your position on the sphere and fastening a string in the hole. This



makes it possible to stretch the string to another point to determine great circle directions without using three hands and a couple of feet. Use string that does not stretch much; it then can be inked at each 1000 miles to facilitate measuring long distances with an error of a hundred miles or so.

Can QRM Be Reduced?

[*Continued from Page 73*]

use of more power than that as "bad taste." Power can be reduced by coupling the antenna to earlier stages than the high power final, putting a resistance or impedance in series with the plate transformer, or changing the plate voltage or bias somewhere in the transmitter.

So much for the more mechanical things. Additional improvement can come through better operating practices such as not leaving a phone carrier on when talking with someone in the operating room or answering the telephone; whistling into the microphone; stepping on the key to draw out long flames from the final tank to amuse visitors; adjusting the "bug" dots over the air. There are many small factors which may reduce the QRM 5% to 25%, which altogether might halve the amount of transmission. Let's review some of them.

Many have discovered that the percentage of stations raised on calls is highest for frequencies near the edges of bands. That has piled up a mess on every edge, and caused much out-of-band operation. Hundreds were heard outside of our bands during the 1937 dx contest—many of them intentionally out, no doubt, judging from the amount they were out beyond our edge-of-the-band crystals. It is reasonable to expect a station to tune around his own frequency, or to cover his end of a band systematically in which case the edges become very effective as calling frequencies. It may be too early in the game to get fellows to call say on 7010 than switch to 7230 for the QSO, but the mess on the edge will be improved if none call CQ there, and contacts are made on schedules—reserving perhaps 25 kc. solely for calling and subsequent working. Here again we don't propose a law, simply a code—and if no one will answer a CQ on an edge-of-band frequency, the CQ caller will soon get lonesome and move in to a less congested channel.

After the 1934 VK contest we suggested use of a series of Q signals to indicate how the receiver was to be tuned following a CQ or QRZ? This was published in RADIO at the time, following which Art Bates of W9FO

picked out QLM, QML, QMH and QHM as the best signals indicating low, middle and high frequencies in the band. This idea was taken up by the A.R.R.L. for dx contests and is still used. In R/9 and QST for December, 1935, was urged the use of these signs at all times, contest or no, to reduce futile answering on a frequency that just wouldn't be covered by the station calling CQ. We still think that this will make for less useless calling, thus less general QRM. A few hours in the 1937 dx test convinced us that dx not using these Q signals makes us do plenty of calling—and swearing—with much really needless interference and loss of an otherwise good disposition.

We soon found that some stations had a hundred or more replies to a call, and simply moved the receiver a dial division or so between contacts, gradually working along the band. But every time a contact was finished, the whole band became alive with calls again. So in the same article we suggested the use of *QSX—"I will listen (for. . .) on . . . kc."* at the end of the QSO, CQ, or QRZ? to indicate the approximate frequency the dx station is covering at the time. This has apparently not been taken up by the gang.

The QSX idea plugs the other hole in this business of scientific tuning after calling CQ, and gives the man who tunes his own part of the band a way to indicate his tuning system and save QRM to others due to calls from the edges and miscellaneous frequencies in the band.

We are not trying to impose our ideas on everyone else in the game. We just want to stir up some thought and direct it where it will do most good. It is fine to send letters to the magazines with various proposals, but copies should be sent to Hartford and to the League directors in an attempt to work out the practical ideas and get the League to establish a code of some sort. The League through its various contests can impress many ideas upon hte majority of amateurs just as it has increased the use of the RST system against much early opposition, through the dx contest serial numbers.

The League directors meet in May. Now is your chance to make suggestions to your director so he will be armed with ideas.

◆

The Question Box

I am experiencing difficulty in neutralizing my final amplifier. At times, especially when I first turn the rig on, it appears to be perfectly neutralized. Then, after it has been operating long enough to become warmed up thoroughly, if I check it with a thermo-galvanometer or pickup lamp a very positive and quite strong indication of r.f. is obtained. Also the amplifier seems to be drawing a few ma. of plate current even though the primary to the plate transformer has been opened. After this it is apparently impossible to neutralize the stage.

The difficulty you mention occurs quite frequently. It is caused by a certain amount of plate voltage actually appearing on the plates of the tubes after the rig has warmed up. This voltage comes from the final plate supply even though the primary of the plate transformer may be open. It can be coupled

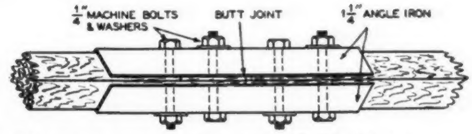
into the supply from a number of different sources. First, r.f. pickup in the a.c. wiring can feed to the plates of the rectifiers, there be rectified and filtered, and finally fed as plate voltage to the final stage. Second, line frequency a.c. can be similarly picked up and rectified to cause the identical trouble. This a.c. line pickup can come from: long leads to the switch in the primary of the plate transformer (which will cause capacity coupling between the hot side of the line and the primary winding), a.c. line filters which cause a similar effect, and most commonly, inductive coupling from the core of one or more transformers that are operating to the core of the final power supply plate transformer.

This trouble can be cured by a couple of simple methods. By far the easiest of these is simply to open the switch that lights the filaments of the high-voltage rectifiers when neutralizing the final. This expedient will not eliminate the cause but it will very effectively eliminate the trouble.

•

I am having considerable trouble with fuse blow-outs on my transmitter. The total drain of the rig is only of the order of 15 amperes but every day or so one of the 30 ampere fuses in the line will get very hot and blow when I am on the air.

The cure for your trouble is very simple. The fuses in your case are blowing from contact heating rather than from an actual overload. Sandpaper the contacts and the inside of the socket in which the fuses are placed. It is also a good idea to sandpaper the sleeve and the contacts of the fuses themselves. By thus reducing the contact resistance the heating will be greatly reduced. In the future the fuses should only blow from overload.



Here is a very neat method of joining 2 x 2 stock for antenna masts. It makes a very strong butt joint.

The sketch is self-explanatory. The angles can be drilled in pairs, thus making sure that the holes for each pair match. As the average "2 x 2" seldom measures more than 1⅝ inches when surfaced, the 1¼ inch angle iron is plenty large. —*W8HIG.*

Twenty Years Ago This Month

We remarked in a "stray" in a recent issue that *QST* once ran an advertisement in RADIO. In response to many raised eyebrows, we are presenting the proof above. The ad ran in *Pacific Radio News,* later called just RADIO, in the April, 1917, issue. My, my, times certainly change.

◆

W1DID has thought up an improvement for the dreaded cards from Grand Island, Hingham, and Portland—an RST report on each.

Are You Insured?

For the small sum of $2.50 we will insure any amateur in the U.S.A. against missing any of the important developments in radio for a period of one year. We will guarantee that at the end of the year he will be endowed with an invaluable store of ideas obtainable nowhere except in RADIO.

•

No physical examination is required; this endowment policy will be issued to any wide-awake amateur who realizes the importance of keeping step with the rapid strides being taken by amateur radio.

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In this unusual policy the insured is also the beneficiary, and the premiums amount to less than three quarters of a cent a day. An application blank will be found on page 93. Remember, this company is a "mutual" organization; it is just what the policy-holders make it. The larger the number of policy-holders, the larger the dividends. Don't delay; insure today.

The "Bi-Push" Exciter

[*Continued from Page 15*]

with the fact that the 6L6's are doubling (and changes in plate voltage react very little upon the grid circuit), keeps the frequency modulation down to a negligible value. The frequency modulation with the rig properly adjusted is no greater than for a suppressor-modulated pentode doubler driven directly from a 40 meter crystal oscillator (a combination widely used).

A careful check revealed the frequency modulation to be so low as to be almost imperceptible on 20 meters. Requests on the air for frequency modulation checks resulted in everyone reporting "nil". While we are not familiar with the F.C.C.'s attitude on the matter of buffer stages, we do know that the F.C.C. is more interested in the results achieved than the procedure or equipment used to achieve the results. The frequency modulation is certainly no greater than that of the many e.c.-oscillator-controlled 20 meter phones, and in any case is so low that no one will be able to tell whether you are using none, 1, 3, or 5 buffer stages unless he has laboratory measuring equipment.

On 10 meters the second 6A6 acts as a buffer, and therefore we do not have to concern ourselves with frequency modulation.

Output Coupling

The antenna, feeders, or grid of the high-power amplifier must be inductively coupled to the output of the 6L6's. Link coupling to the following stage is perhaps the best method of feeding a high-power amplifier. Any of the common inductive coupling methods may be used for coupling antenna or feed line to the output tank of the 6L6's. If desired, a two-turn link can be permanently mounted in such a manner that coils may be changed without disturbing the link. Two turns of no. 12 enamelled wire, 2¼" in diameter, may be mounted on standoffs to encircle whatever coil happens to be in coil socket "C".

Precautions

Do not apply plate voltage without first making sure that the band-switch is thrown to the proper position.

Do not attempt to change any of the coils with the plate voltage on.

Do not remove the coil from socket "C" with the plate voltage on, or apply plate voltage without a coil in this socket. Failure to observe this may result in damage to the screens of the 6L6's.

Do not leave the plate voltage on the 6L6's for more than 10 or 15 seconds with the excitation removed, unless jack J_3 is open (or the key up).

High-grade ceramic sockets must be used for the 6L6's and coil socket "C" or the output at 10 meters will suffer. The same holds for the insulation on C_{12}.

Amelia and Amateur Radio

As we go to press, Amelia Earhart is repairing her plane preparatory to taking off for Howland Island, tiny speck of land 1600 miles Southwest of Hawaii. Perhaps before the last leg of the globe-circling tour is completed amateur radio will have had a chance to be of invaluable service. That is why she was anxious to secure the cooperation and good will of amateurs throughout the world. Already amateur radio has had a chance to prove its worth, for on the first leg of the flight the plane was out of contact with the world for approximately four hours except for amateur station W6NNR, Los Angeles. During that time two-way communication was maintained, with W6NNR on 75 meter phone and the plane, KHAQQ, on 3105 kc. phone and c.w. W6NNR was able to copy the plane's signals solid until the plane neared Honolulu, and they reported W6NNR's signals as being of good signal strength at all times during the hop. During the four hours that the signals of KHAQQ were inaudible except at W6NNR, all messages were relayed through this station until regular communication with the scheduled stations was resumed.

A relief shift "holding down the fort" at W6NNR while Guy Dennis catches a few winks of much needed rest. The handle for the "signal squirter" can be seen hanging down from the ceiling.

For several weeks Guy H. Dennis, owner-operator of the station, has been lining up a chain of amateur stations on the charted course of the plane around the globe. It was no easy task, and at the present time the chain is not entirely complete, though arrangements are being made to fill in the gaps before the plane will reach those positions on the globe. Miss Earhart will not rely upon amateurs for communication during flight except in emergencies. The amateur service will be supplementary, just as a precaution in case other communication should fail. However, it is expected that there will be several occasions upon which amateur radio will be called upon to render service of one kind or another.

The flight will be made in easy stages, as it is not an attempt at a speed record. Jumps of

500 or so miles will be common except where longer hops over water are necessary. For the reason that the contemplated places of call are not definite, it was necessary to line up amateurs all along the route, so that no matter where she should make a stopover there would be an amateur station not too far away. The amateur stations will also assist in relaying messages back from the plane to the sponsors of the flight in the United States, and be available for sending orders for gasoline or other supplies should the plane land in some out-of-the-way place.

As an example of typical amateur cooperation K6AYD, K6CRW and K6NTV at Maui labored three days straight to put on a 500 watt 75 meter phone station at K6NTV so that they would be able to assist should the occasion arise. At is happened everything clicked as the plane neared Honolulu, and their assistance was not necessary. However, they were on the job relaying and repeating back each message as the plane neared Honolulu. Had not things clicked as they did, these amateurs might have been much in the limelight. However, the labor spent in preparation was just as great, and their work is none the less praiseworthy just because an emergency did not arise.

W6NNR and K6NTV were in communication on 75 and 20 meter phone several times an hour from 6:00 p.m. P.s.t. the evening the plane took off till 8:30 a.m. P.s.t. the following morning—a tribute to the reliability of amateur communication.

On Howland Island, next stop on the flight, is K6GNW, with whom W6NNR is keeping schedules. Other stations of the chain are:

K6BAZ, K6MTE, Honolulu; VK4DJ, VK2ADV, VK8AA, Australia; CL3AC, Kupang; PK3BZ, PK1BB, PK1MO, PK1PK, PK1RT, PK1VM, Dutch East Indies; VS1AB, VS1AF, VS1AJ, VS3AA, Malay. HS1PJ, HS1RJ, Siam; VU2BJ, VU2LZ, VU2EM, Burma; VU2AS, VU2CS, VU2HQ, VU2JN, VU2LM, VU2HV, VU2BX, India.

VU1AN, Aden; ST2WF, Africa (This is perhaps the most perilous part of the trip, and there are but few amateur stations on the proposed route across Northern Africa); PY7AA, PY7AB, Brazil; PZ1AB, PZ1AL, Dutch Guiana; FY8C, French Guiana; VB3BG, British Guiana; VP4TC, VP4TH, Trinidad; YV5AK, YV2AM, Venezuela; HP1A, Panama; YN1AA, Nicaragua; TG2JZ, Guatamala; XE1JF, XE1AW, XE1GC, XE1AH, XE1G, XE1BZ, Mexico; and W6NNR, Los Angeles.

While these amateur stations have teamed up in order to handle the job more effectively and permit relaying of messages along the route, all amateur stations along the route are invited to listen for the plane's signals when in their vicinity and to stand by to be of assistance should occasion arise. The plane, a twin-motored Lockheed Electra, is equipped with a 50 watt phone-c.w. rig on 3105 and 6210 kc. It is also equipped for 500 kc. operation. Amateurs can identify the plane visually by the number NR16020.

When the plane hits Australia, George Putnam, husband of Amelia Earhart, will go to New York to be in closer contact with the plane on the balance of the trip. He will work with amateurs through stations W2APV and W2FPT.

The amateur key station, W6NNR, uses a single 150-T modulated by 203-A's in class B.

[*Continued on Next Page*]

W6NNR will be recognized by many old timers by the calls ex-6CR and ex-6BAI.

On 20 meters a rotatable signal squirter is used, and on 75 an end-fed Hertz. With 800 watts input the transmitter lays down a good signal to all stations in the chain on 20 meter phone.

At the time of this writing it is not definitely assured that the flight will be continued, in view of the take-off crack-up at Hawaii. However, one thing is assured: The amateurs throughout the world will be standing by to do their bit if the flight goes ahead as planned.

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Our Webster's defines a radiotelegram as a message transmitted by *radiotelegraph*. That leaves us without a term for messages exchanged by radiophone!

◆

IRC VOLUME CONTROL GUIDE

Announcement of an IRC Volume Control Guide is made by International Resistance Co., 401 North Broad St., Philadelphia, Pa. It is available free to servicemen and amateurs who request it from IRC jobbers.

This Guide is attractively printed in handy pocket size with durable covers and is punched for convenience in hanging near the user's service bench. It lists in detail the IRC Standard Controls recommended for leading radio receivers, thus greatly simplifying the job of making quick, accurate replacements.

Radio's Overseas Buying Service

Lately a number of our readers in countries bordering on the Pacific have forwarded us money requesting us to purchase certain radio parts for them, stating in some cases that they have been poorly, if not fraudulently, served by certain mail order houses.

The great majority of U.S.A. mail order and export houses give prompt, honest, and accurate service. If you are already dealing with such a house, there will be no advantage whatever in diverting orders to us.

However, for readers who have no such relations, we will accept orders and place them with houses believed by us to be reliable.

A charge of $1.00 per order will be made for this service (to cover actual handling costs) which will be available only to subscribers.

As we make no profit we can accept no responsibility beyond the exercise of our best care and judgment. If you do not know the exact amount of money required, send more than sufficient; the balance will be promptly refunded, less only exchange charges and money transfer fees, or, if so requested, we will hold the balance on our books to your credit against future orders.

Be sure to specify **exactly** what items are wanted. We cannot undertake to determine what size condenser will go best with your coil, what tube is the most efficient for your rig, or what type of resistors were used in a transmitter in somebody's magazine last year.

Automatic Bias for Class B Modulators

By L. Mauerer*

During the last few years the class B operation of triodes has found an ever-increasing use in high-powered public address work and in transmitting practice. The advantages of class B operation have been so thoroughly treated in the published literature that we will not repeat them here.

While the smaller tubes designed for radio receiving and public address work have been developed to work without bias, most power tubes used for transmitting must be negatively biased to near the cut-off point to obtain the proper operating characteristics. The methods used at the present to obtain this bias voltage for audio frequency amplifiers are batteries, rectified and filtered a.c. supplies, or sometimes d.c. generators for large installations. Batteries are of course cumbersome and must be frequently replaced and a.c. supplies must be unproportionately heavy to insure good regulation. In other words, both are expensive and bulky.

The usual way of biasing power tubes by means of a resistor between the cathodes or filaments and ground, is not applicable to class B tubes since the resultant cathode current does not remain constant as in class A operation.

The new method to be described uses a combination of a bias resistor, two or more suitable tubes in parallel with this resistor, and a bypass condenser across them both. The grids of the bias tubes are connected to taps on the same driver transformer which feeds the grids of the class B power tubes. The bias resistor is so chosen that the no-signal plate current of the tubes develops the desired bias voltage. The tubes in parallel with the bias resistor under these conditions have a high internal resistance and consequently influence the bias voltage very little. As a signal is applied to the power tubes and at the same time to the bias tubes, the internal resistance of the latter decreases in such a manner that the product of the power tube plate current and the effective resistance of the bias resistor shunted by the bias tubes, remains constant over the operating range. Consequently, the voltage drop across this resistor, which is of course the bias voltage, fluctuates very little under signal.

The fundamental circuit is shown in figure 1. Two bias tubes are necessary since their grids must be actuated from the driver transformer exactly in phase with the respective power tube grids. In this way it is possible to obtain a current half cycle in one bias tube to correspond to a current half cycle in one power tube.

Figure 2 shows a family of plate current, plate voltage curves for a zero bias class B power tube as published by a tube manufacturer. If a vertical line is drawn from a point on the abscissa corresponding to the desired bias voltage, the intersections of this line with the curves determine the plate currents for the respective grid voltages. While this relation between plate current and grid voltage is not as linear as would be desirable, it will correspond well enough to the plate current variations in a class B power tube driven by the same signal to supply steady bias voltage with only a small amount of ripple. Since the above mentioned linearity is quite important, the bias voltage

*Jefferson Electric Co.

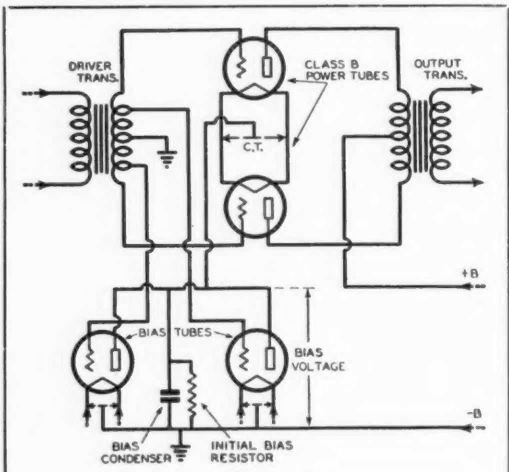

Figure 1

line, as drawn on the curves, must not intersect these curves at or near one of the bends or knees.

In order that a tube be suitable as a bias tube, it must be able to carry the maximum crest value of I_p flowing in one power tube at the desired bias voltage. This bias tube current may be smaller by the amount of current flowing through the resistor R at zero signal. R is determined by the zero signal plate current in both power tubes minus the plate current in both bias tubes at the operating bias on the power tubes. The quantity obtained above, if divided into the operating bias desired, will give the correct value for the resistor R. It is desirable that the maximum signal crest value for the bias tube grids does not exceed the power tube bias voltage. If this precaution is not taken, non-linearity difficulties may be encountered due to the tube's approaching the diode bend in their characteristic.

Knowing the signal voltage relation between

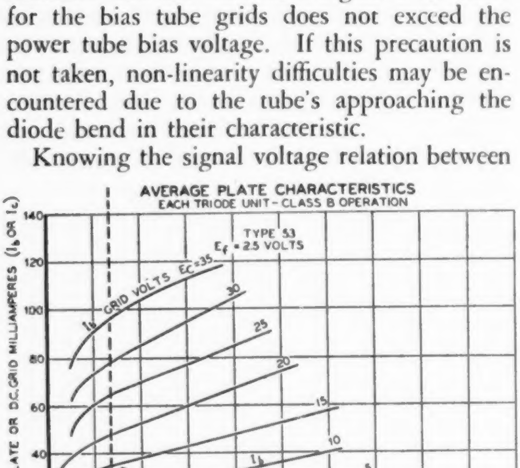

Figure 2

the power tube and bias tube grids (obtained from the characteristic data on the tubes), the driver transformer can be properly tapped. It has been found in practice that a slightly higher voltage than calculated should be provided for the bias tube grids and that final adjustments be made by means of series resistors between the transformer taps and these grids. This resistance adjustment helps to compensate for differences in tube characteristics. The system can also be operated with dropping resistors only between power tube and bias tube grids. This method, however, is quite inferior to the tapped transformer. The voltage wave shape on the bias tube grids will be distorted due to the non-linear grid current flow. In addition the driving power must be increased to bear the losses in these resistors.

It must be remembered that driving power

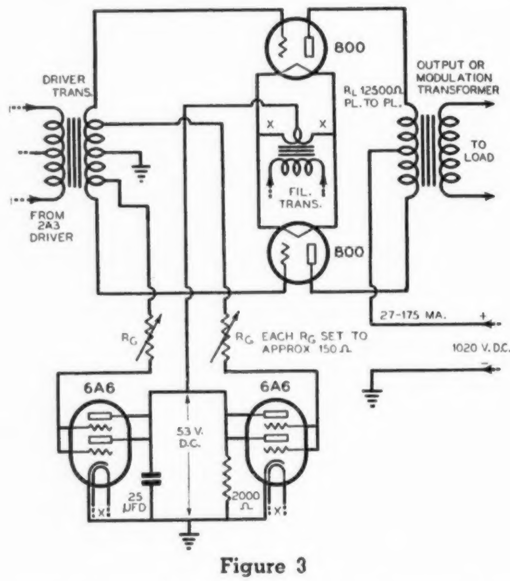

Figure 3

must be provided for the bias tube as well as the power tube grids. This driving power is quite considerable. In some cases, depending on the combination used, it may be as high or even higher than the power tube grid drive needed.

Zero bias class B tubes or high μ triodes are best suited for bias tube service. At the low plate voltage (bias on the power tubes) used, such tubes draw little zero-signal plate current with their grids returned to ground. Zero bias class B tubes are designed to deliver considerable power with relatively low plate voltages and high plate currents. Therefore they can well be matched with higher powered tubes that op-

erate at high plate voltages with moderate plate currents.

In order to illustrate the principle more clearly, an actual example which has been thoroughly tested will be described. As can be seen in figure 3, two 6A6 tubes with their respective grids and plates in parallel are used as bias tubes for a pair of 800's in the power stage. The grid and bias resistors were so adjusted that the d.c. bias voltage was 53 volts at no signal input as well as for maximum output of 100 watts. The d.c. bias variation amounted to a 6% drop somewhere between zero and maximum output. The ripple voltage impressed on the bias at full signal was 3% measured at 100 cycles. The ripple frequency was determined to be twice the signal frequency by means of a cathode ray oscilloscope. The same instrument was used to compare the waveform obtained with this system with that obtained when using battery bias. No difference was discernible. The above combination was driven by a 15 watt push-pull 2A3 amplifier. The driving power required for full output at 250 cycles was approximately 8 watts for both the 800's and the 6A6's.

In summing up, it can be said that this system offers these advantages. It is simple to construct, occupies very little space, and is less expensive than the conventional biasing methods . An additional safety feature of the system is the protection offered the usually expensive power tubes by the fact that a bias tube failure will not leave the power tubes without bias. As a matter of fact it will actually increase the bias slightly. Against these advantages stands the need for the additional driving power required by the bias tubes. However, in most practical installations this slight additional need can be met with very little difficulty.

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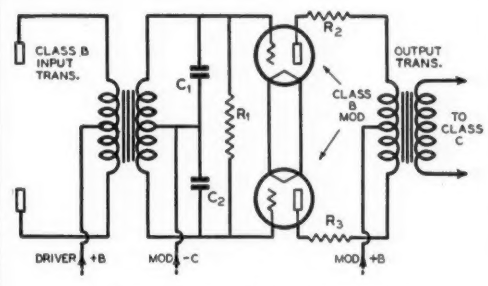
THE QUESTION BOX

My phone transmitter seems to have two spurious sidebands about 20 or 30 kc. each side of the main carrier. The two sidebands disappear, however, when I modulate the transmitter—only to reappear as soon as I quit modulating. I am using class B modulation and the instant I turn off the modulator the sidebands also disappear.

Your difficulty sounds very much as though oscillation in the class B modulator were causing the trouble. Class B modulation systems have a tendency to regenerate and frequently even to oscillate in the higher audio spectrum. Since the frequencies are in the range from 20 to 30 kc., the oscillations are usually quite easy to stop by means of a few resistors and condensers judiciously placed in the circuit. The accompanying diagram will give an idea of the approximate values and proper positions for the condensers and resistors. All the components may not be needed to cure the condition. The resistor R_1, however, will improve the performance of almost any class B or AB modulator. It should have a value of from about 10,000 ohms for low impedance grid tubes such as the 46, 838, -03A, etc., to about 50,000 ohms for tubes such as the 845, 50, 284B, etc. Tubes with intermediate values of grid impedance should have appropriate intermediate valuee of of R_1. The condensers and the resistors R_2 and R_3 should be used only when required to stop the parasitic oscillations.



The Circuit Under Discussion

C_1, C_2—.001 µfd. mica
R_1—10,000 to 50,000 ohm resistor
R_2, R_3—50 ohms, 10w.

Chasing Down Interference*

Perhaps the greatest obstacle yet to be overcome in radio communication is interference. In the popular mind, interference or "static" is any kind of sound other than the desired program. Therefore it is best to begin by defining terms. Interference may be divided into four kinds:

1. Natural static.
2. Interference originating in the receiver.
3. Interference from other stations or the neighbor's receiver.
4. Interference caused by electrical machinery in the vicinity.

Natural static cannot be completely eliminated at the present time. It is however but a small part of the interference which mars radio reception. The types 2 and 3 are clearly due to faulty receivers and should be remedied by competent servicemen. This article is concerned with interference of the last type.

What Causes Interference?

Whenever switches are closed, a spark jumps or there is any sudden change in the current carried by a conductor, a damped radio wave is radiated. This radio wave may eventually reach receivers in the neighborhood and because it is damped it will cause interference at different frequencies by impact excitation. The result is a multitude of noises in locations where many electrical devices are used, such as apartment houses and most locations in large cities. To mention but a few causes, radio interference is created by ordinary switches, vacuum cleaners, oil burners, electrical refrigerators, elevators, thermostat controled devices. It is also caused by dial telephones, buzzers, passing streetcars, trains and automobiles.

One other cause not usually considered is any intermitten contact between two conductors, both of which may appear quite dead since they are not connected to any electric wiring system. This is, for instance, the case if two aerial wires sway in the wind and touch each other. This not only causes interference in the receivers to which these aerials are connected, but also affects reception in all other receivers in the immediate neighborhood. The same effect is obtained by any other wires, not aerials, which may be swaying in the wind and touching another conductor such as guy wires, etc. The remedy is obvious.

How Interference Travels

The damped wave can travel to the receiver by any or all of four ways. First, it may be radiated directly by the wires; second, it can be conducted along the power wires and reach the receiver in that way. Third, it may be conducted along the power wires and radiated by them to the aerial. Fourth, it can be re-radiated by another conductor nearby.

The directly radiated interference reaches the receiver by way of the antenna and is therefore encountered on battery receivers as well as on line-operated receivers. Obviously it cannot be eliminated except by suppression at the source or by means of a special antenna situated away from the interference zone and supplied by a noise-cancelling lead-in. This is often possible because directly radiated interference does not travel very far, perhaps no more than 80 feet.

The second type, conducted interference, appears on line-operated sets only, which suggests a way of testing for it. It can be reduced by means of a line filter at the outlet of the power line where the receiver is plugged in. Of course, suppression at the source is still better. This type of interference is usually accompanied by the third type which is by far the most com-

*By the Engineering Department, Aerovox Corporation

mon of the four. The interference travels by wire and is radiated by the wiring in the walls if it is not perfectly shielded and by the power cord. This type may travel for several blocks and the radiation may take place by the wiring in the neighbor's house as well. One suggested remedy is to filter the power wiring at the point of entrance to the house, but this may not be sufficient in apartment houses and other crowded locations where the unfiltered wiring of the neighbor is still near enough to cause damage. The special aerial may have to be used as well if the noise cannot be stopped at the source.

The fourth type of interference comes in by the antenna and the same remedies as for the first type should be employed.

Hunting the Cause

When interference is encountered the first thing to do is to determine in which one of the four ways it is reaching the receiver. It then will be easier to decide on the best way of elimination. It is of course best if the search continues until the offending device is found. Many electrical appliances have their own characteristic noise which can be recognized by an experienced man.

Before blaming the interference on the surroundings it must be established that the receiver itself is not to blame. Bad connections may cause a frying noise and defective tubes may cause intermittent buzzing. These are often hard to locate; the old test of disconnecting aerial and ground is not always reliable because some noises occur only when a signal is coming in. Tapping various parts of the receiver and the tubes will often help finding the cause. Wherever possible another receiver should be tried in the same location.

Assuming that the receiver is blameless, disconnect aerial and ground and short circuit the aerial and ground binding post by a short wire. If the noise remains equally strong, it is the second, the conducted type. If the noise did not disappear completely it came in by the antenna alone and belongs to the radiated or reradiated type. If the noise became weaker it probably belongs to the third type, that radiated by the powerline, or it is a combination of several types.

A test for direct conducted interference is the use of a battery receiver which will not pick up this type. Interference radiated by the power line can usually be identified by tuning through the dial and down to the short waves. If the trouble becomes worse on the short waves it is usually due to direct radiation and the source is probably within fifty feet. If the interference is worse on the long waves, the interference is probably carried along the power line and radiated by it. The source may then be several blocks away.

The above tests will give a clue to the probable location of the cause; it can be further traced by the use of a portable battery receiver and by a process of elimination, turning off the power in the house or in separate circuits. This will establish whether the line is at fault, because the line radiated interference will disappear if a battery receiver is used and the power in the house is turned off.

Chasing down interference and identifying it is three quarters of the battle; there is a specific cure for most of the various types if one but knows just how the interference is reaching the receiver.

Osockme, Japan.

Radio Magazeen, Lost Angels, Calif.

Dear Gentlemen and Ed:

Well, hon ed., Scratchi are now grate entertainer and stuffs. Here are how it are all come about.

Scratchi are wander down town other night with nothings much to do on mind and see big sine on door of Osockme Paradise Palace Cafe which are read "Amateur Night". So Scratchi go in with expectancy of see many Osockme ham friend.

They are hams all right, hon ed., but not kind Scratchi expect to see. They are all ham actors and entertainers out of employ who are try to pass selfs off as amachoors so as to win first prize of 50 yen, which are to be give to fellow who are put on the best impromptoe act.

Now Scratchi are no slouch when it come to plane and fancy stuffs with feets. In fack they are call me "Sugar Foots Scratchi" on accounts of I are swing the feets so good.

The y.l.'s were well represented in the recent QSL contest. Here are three of the many y.l. cards received.

After fifth snootsful of Saki I are feel very light on dogs and are think I can putting that Astaire fellow to shame. So I get Major Bowshamura to putting me down as entrant number 14.

They don't paying much attention when I are start, because taking me a minute to get warm up. But when Hank Hashamura and his swing band are really cut loose and Scratchi toss off two more Saki and soda and are start going to town, the prize are in the sack. Scratchi's feets fly over the floor so fast that are cause static in radio receivers for two blocks.

Well, hon ed., when I are finish up by singing "I Can't Giving You Anything but Loves, Baby", it sound as good as the great Bing Kinoshi hisself. This are lay low the ladies present, which make it a cinch to get the prize, which I are do all right.

Besides the 50 yen, with which I are buy me new pair of bottle for my rig, are getting also a hot stuffs trofey cup, all engrave with "Hashafisti Scratchi, First Award, Osockme Open Amateur Contest".

I are have a slick picture of this cup which I are took, hon ed., and was wondering what you think of running in magazeen saying I won it in code contest at Osockme Radio Club convention. Since get on

phone everybody kid Scratchi that he forget the code, and therefore have to going on phone. If you could running same in your hon rag it would making those fellows have more respeck for my fist.

Respectively yours,
HASHAFISTI SCRATCHI.

P.S.: Can telling me please where can renting free an Instructograph or Teleplex for a few weeks? Are wanting it for another fellow of course.

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Man Bites Dog

At a recent amateur license examination in Chicago, only 8 of the 24 present passed the 13 word a minute code test. Most were caught at not being able to *send* without error for one minute. Only two or three of the group were youngsters; the rest included a lawyer, a doctor, the man in charge of radio installation and maintenance of an airway, and a lubrication engineer.

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Amateur radio has really been getting some publicity of late. Newest feature article on amateur radio appears on page 97 of the March, 1937, issue of *Esquire,* W6BJM author.

BUYER'S GUIDE

Where to Buy It

CALIFORNIA — Los Angeles

Radio Supply Company
912 So. Broadway

THE AMATEURS' HEADQUARTERS OF THE WEST

All Nationally Advertised Parts for Receiving and Transmitting Carried in Stock at All Times. 9 Licensed Amateurs on Our Staff.

ILLINOIS — Chicago

CHICAGO RADIO APPARATUS CO., Inc.

Established 1921

415 SOUTH DEARBORN STREET
(Near Van Buren Street)

ALL SUPPLIES FOR THE SHORT WAVE FAN AND RADIO AMATEUR QUOTATIONS FREELY GIVEN ON ANY KIT OR LAYOUT

Short Wave Receivers Taken in Trade
Get our low prices

MARYLAND—Baltimore

Radio Electric Service Co

3 North Howard Street
Baltimore, Md.

MICHIGAN — Flint

Shand Radio Specialties

203 West Kearsley Street
Flint, Mich.

MISSOURI — St. Louis

WALTER ASHE RADIO CO.

11th and Pine Streets
St. Louis, Mo.

PENNSYLVANIA — Pittsburgh

Tri-State Radio Equipment Company

403 Penn Avenue
Pittsburgh, Pa.
W8FQ and W8MYM ready to serve you

PARTS REQUIRED FOR BUILDING EQUIPMENT SHOWN IN THIS ISSUE

The parts listed are the components of the models built by the author or by "Radio's" Laboratory staff. Other parts of equal merit and equivalent electrical characteristics usually may be substituted without materially affecting the performance of the unit.

THE ADAMS RECEIVER

Dial—Crowe 317 Micromaster
$TR_{1, 2, 3}$—Meissner type 5780
TR_4 — Meissner Ferrocart type 5740
TR_5 — Meissner Ferrocart type 6131
TR_6—Meissner type 5714
TR_7—Meissner type 6762
TR_8—Meissner type 6753
TR_9—Jefferson 463-441
CH—Jefferson 466-125
Sockets, high freq.—Amphenol RSS-8
Sockets, low freq.—Amphenol RS-8
Socket assem., 6G5—Amphenol MEA-6
R_{24}—Electrad 203 potentiometer
R_{33}—Electrad 234W potentiometer
R_2, R_{37}—Electrad 573 potentiometer
Resistors — Continental Carbon insulated
By-pass and coupling condensers—Aerovox
C_{26}—Aerovox PR25 5 µfd.
C_{29}—Aerovox PB25 25 µfd.
C_{36}, C_{37}—Aerovox GGL5 8-8 µfd.
C_{38}—Aerovox GL5 8 µfd.
Chassis—10 x 17 x 3", Hadley MC-102
Panel—12 x 19", 16 gauge

THE BI-PUSH EXCITER

Coil forms, 5 prong (illustrated)—National XR-20-5
Coil forms, 7 prong (not illustrated)—I. C. A. type 955
Ready-made coil kit—Decker Mfg. Co. (not illustrated)
Isolantite base 6L6-G's—Raytheon (not illustrated)
6L6 sockets—National Isolantite octal
Other sockets—Amphenol Isolantite
Meter—Hoyt type 569 0-300 ma.
RFC—I.C.A. type 277 (2.5 mh.)
C_2, C_6—Hammarlund MCD-100-S
C_{12}—National SE-50
J_1, J_2, J_4—Bud no. 233 (closed circuit)
J_3—Bud no. 232 (open circuit)
R_2, R_5—Ohmite 30 watt "Dividohm"
R_1, R_3, R_4, R_7, R_8—Aerovox type 931
R_9—Aerovox type 933
T_1—U.T.C. type LM-4
T_2—Inca type B-15
CH—U.T.C. type CS-305
C_{14}—Aerovox type 608

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